SOIL SURVEY OF

# Outagamie County, Wisconsin

United States Department of Agriculture
Soil Conservation Service
In cooperation with the
Research Division of the College of Agricultural
and Life Sciences
University of Wisconsin

**This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.**

**Major fieldwork for this soil survey was completed in the period 1965–66 and 1970 to 1974. Soil names and descriptions were approved in 1975. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1974. This survey was made cooperatively by the Soil Conservation Service and the Research Division of the College of Agricultural and Life Sciences, University of Wisconsin. It is part of the technical assistance furnished to the Outagamie County Soil and Water Conservation District.**

**The fieldwork for this survey was financed in part by the Outagamie County Soil and Water Conservation District.**

**Soil maps in this survey may be copied without permission, but any enlargement of these maps can cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.**

# HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, woodlands, and wildlife areas; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, recreation, and residential development.

### Locating Soils

All the soils of Outagamie County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

### Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification and woodland ordination symbol of each. It also shows the page where each soil is described and the page for the capability unit in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

*Farmers and those who work with farmers* can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units and woodland groups.

*Foresters and others* can refer to the section "Woodland Management and Productivity" and "Windbreaks and Environmental Plantings" where the soils of the county are grouped according to their suitability for trees.

*Wildlife managers and others* can find information about soils and wildlife in the section "Wildlife Habitat."

*Community planners and others* can read about soil properties that affect the choice of sites for nonindustrial buildings and for recreation areas in the sections "Engineering" and "Recreation."

*Engineers and builders* can find, under "Engineering" and "Soil Properties" tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

*Scientists and others* can read about the soils in the section "Formation and Classification of the Soils."

*Newcomers in Outagamie County* may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given at the beginning of the publication and in the section "Environmental Factors Affecting Soil Use."

# Contents

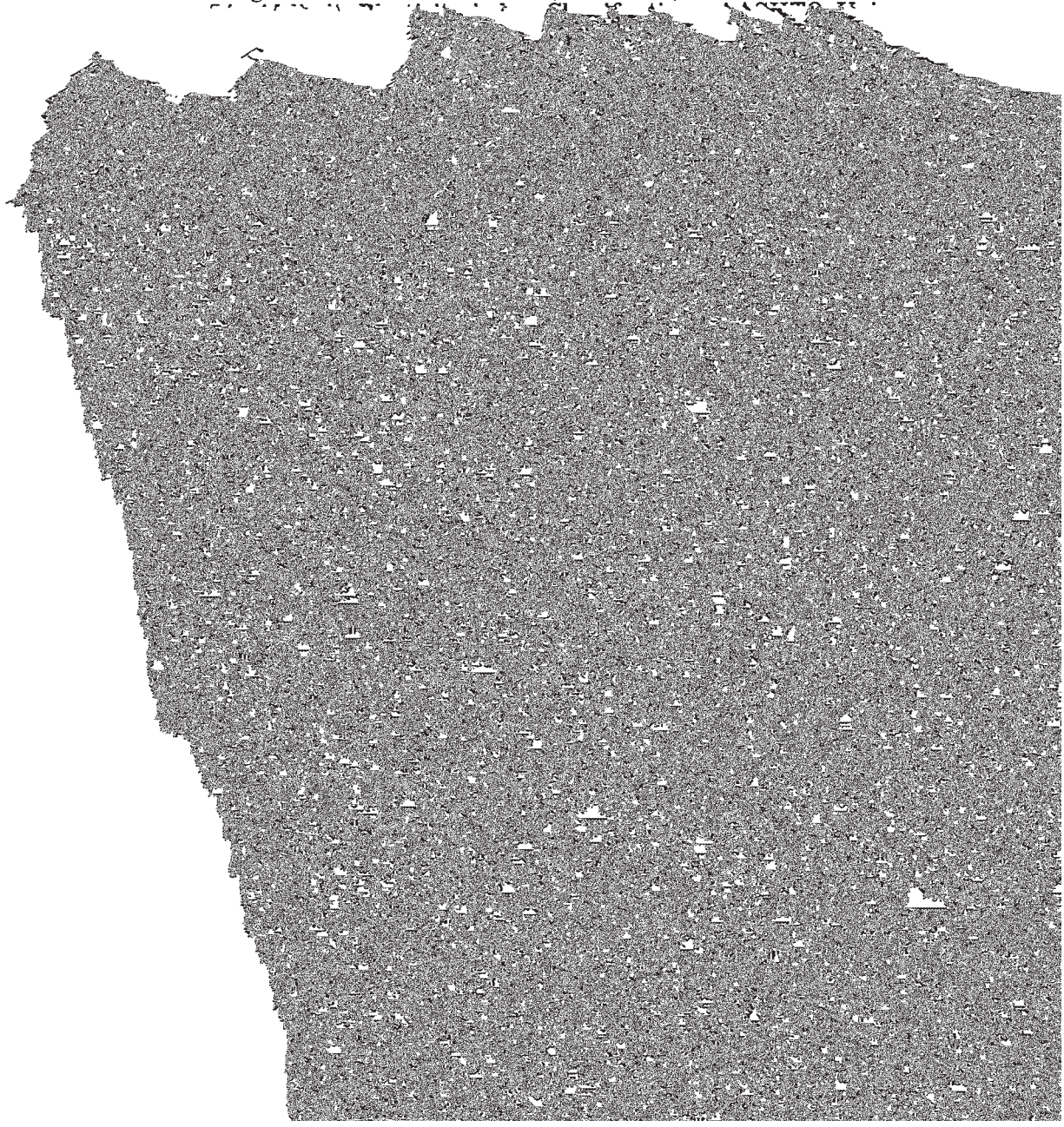


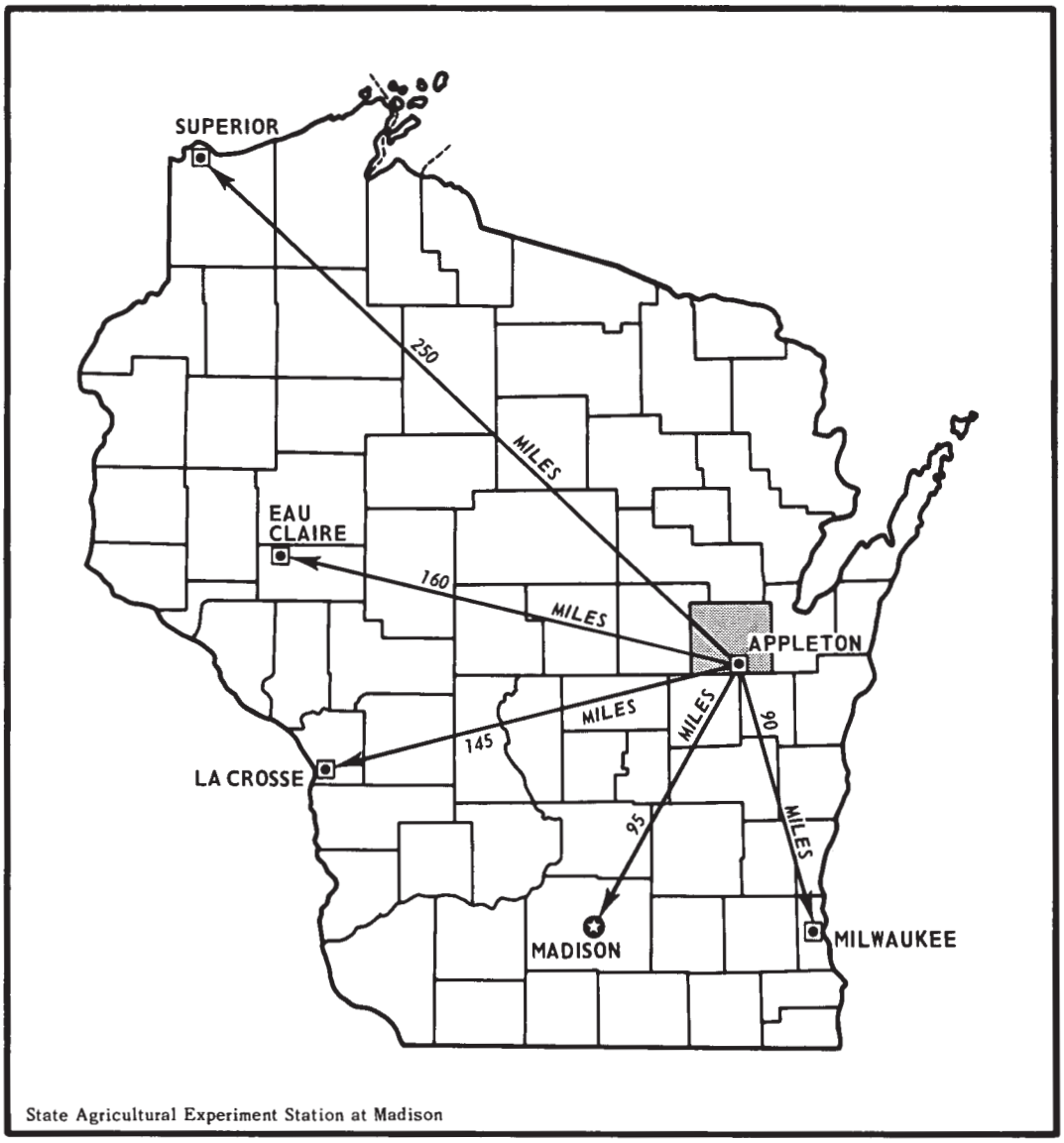
Issued November 1978

# Index to Mapping Units

## Summary of Tables








**Location of Outagamie County in Wisconsin.**

# SOIL SURVEY OF OUTAGAMIE COUNTY, WISCONSIN

By Wayne D. Barndt, assisted by Howard E. Lorenz and Steven W. Frings, Soil Conservation Service

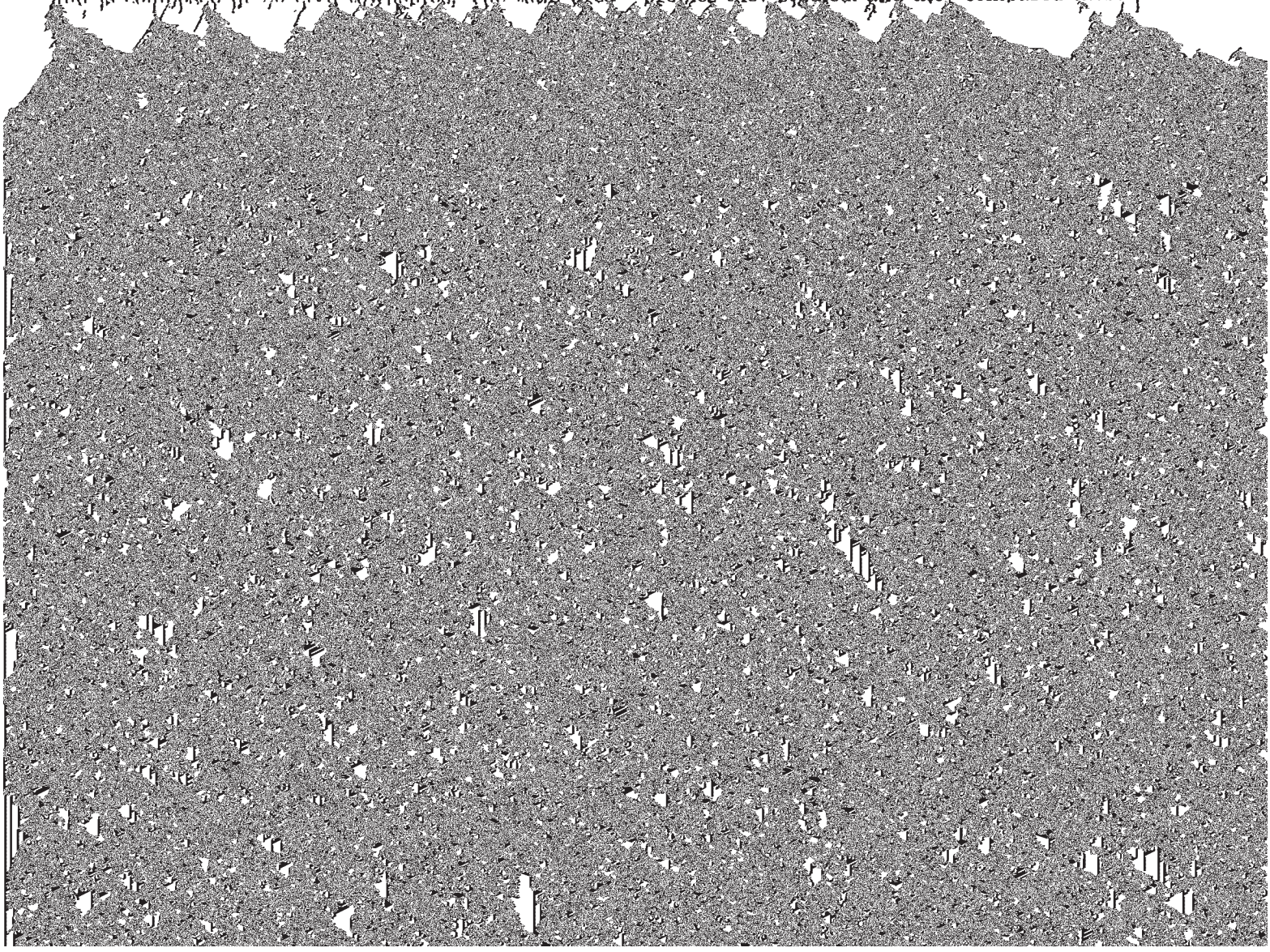
Soils surveyed by Howard E. Lorenz, Steven W. Frings, Ernest G. Link, Charles F. Leonard, Dennis E. Hutchinson, Burel S. Butman, and Wayne D. Barndt, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service, in Cooperation with the Research Division of the College of Agricultural and Life Sciences, University of Wisconsin

OUTAGAMIE COUNTY is in the east-central part of Wisconsin (see facing page). It is about 27 miles from east to west and 24 miles from north to south and is composed of 20 civil townships. The total area

into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles



## General Soil Map

The general soil map at the back of this publication shows, in color, the soil associations in the survey area. A soil association is a unique natural landscape that has a distinct pattern of soils and of relief and drainage. Typically, a soil association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other associations but in a different pattern.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one association differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

The seven soil associations in Outagamie County are described in the pages that follow.

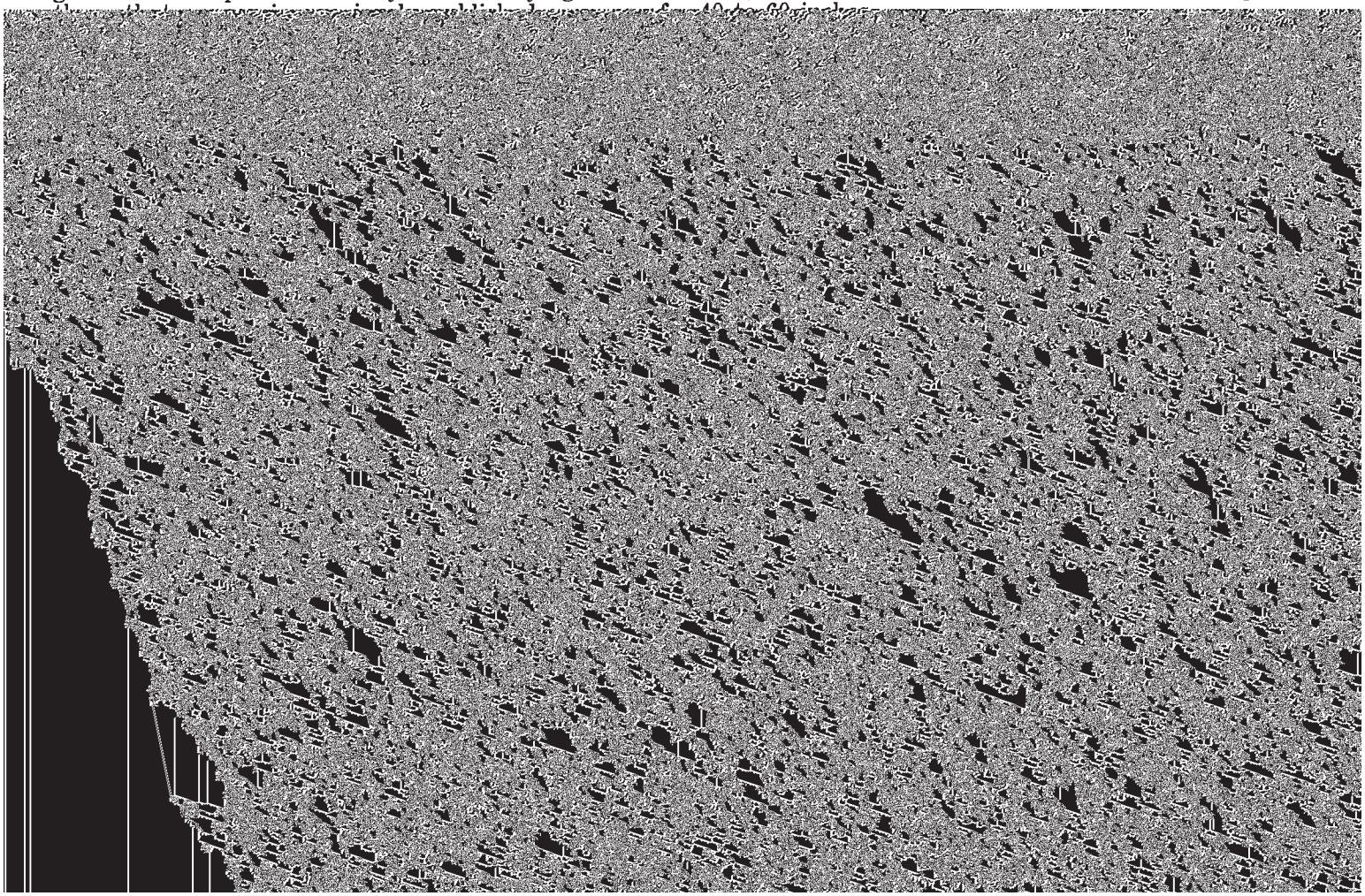
The soil associations and their delineations on the general soil map in this survey do not fully agree with adjacent counties. Some differences result from improvements in the system of classifying soils, particularly in modifications or refinements in concepts of soil series. Other differences from previously published surveys are the pattern of occurrence of some of the major soils and the range in slope that is permitted within some associations described in this survey. Finally, because general soil maps now have more varied uses, the map in this survey is more precise and detailed.

### 1. *Hortonville-Symco association*

*Well drained and somewhat poorly drained, nearly level to steep, medium textured and moderately coarse textured, moderately permeable or moderately slowly permeable soils that are underlain mainly by calcareous loam or clay loam glacial till*

This association consists of nearly level to steep soils on glacial till plains. It makes up about 30 percent of the county. It consists of about 49 percent Hortonville soils, 28 percent Symco soils, and about 23 percent minor soils (fig. 1).

Hortonville soils are well drained and gently sloping to steep and are on till plains. The surface layer is silt loam or fine sandy loam. The subsoil is silty clay loam. The substratum is heavy loam to a depth of about 60 inches except in the Hortonville, limestone substratum soils, which are underlain by limestone at a depth of




Winneconne
Manistee
SANDY MATERIAL
Manawa
Poygan
Winneconne
Allendale
Manawa

ville, Kewaunee, Manistee, Poygan, and Suamico soils. The very poorly drained Suamico soils and the poorly drained Poygan soils are in depressions. Briggsville and Kewaunee soils are intermingled with Winneconne soils on till plains. Allendale and Manistee soils are in areas where there is a 20- to 40-inch sandy mantle over glacial till.

Most of the crops commonly grown in the county do well on soils of this association. Fertility is moderate to high, and available water capacity is moderate. The main concerns of management are controlling erosion, maintaining tilth, and improving drainage.

Most of this association is used for crops or pasture. Very steep soils and poorly drained and very poorly drained soils remain in woodland or, where cleared, are used for permanent pasture. The major enterprise is dairy farming. The major soils in this association have severe limitations for rural home development.

### 3. *Carbondale-Keowns-Cathro association*

*Very poorly drained and poorly drained, nearly level, organic and medium textured, moderately slowly permeable to moderately rapidly permeable soils that are underlain by lacustrine silt and fine sand, organic material, or loamy sediments*

This association consists of nearly level soils in depressional areas and drainageways. It makes up about 16 percent of the county. It consists of about 40 percent Carbondale soils, 30 percent Keowns soils, 10 percent Cathro soils, and 20 percent minor soils (fig. 3).

Carbondale soils are very poorly drained and nearly level. They are in depressions in glacial lake basins and drainageways. They are organic soils that are more than 51 inches thick.

Keowns soils are poorly drained and nearly level. They occupy depressions in glacial lake basins. The surface layer is silt loam. The subsoil is fine sandy loam. The substratum to a depth of about 60 inches is silt and fine sand.

Cathro soils are very poorly drained and nearly level. They are in depressions in glacial lake basins and drainageways. They are organic soils that are underlain by silt loam.

Minor soils in this association are Lobo, Markey, Pella, Poygan, Rondeau, and Suamico soils. The very poorly drained Lobo, Markey, Rondeau, and Suamico soils are in glacial lake basins and depressions. Pella and Poygan soils are in depressions on till plains.

Most areas of this association remain in swamp woodland and are used for wildlife habitat or are idle. Drained areas are used for crops, sod farming, or permanent pasture. Lobo soils are a good source of sphag-

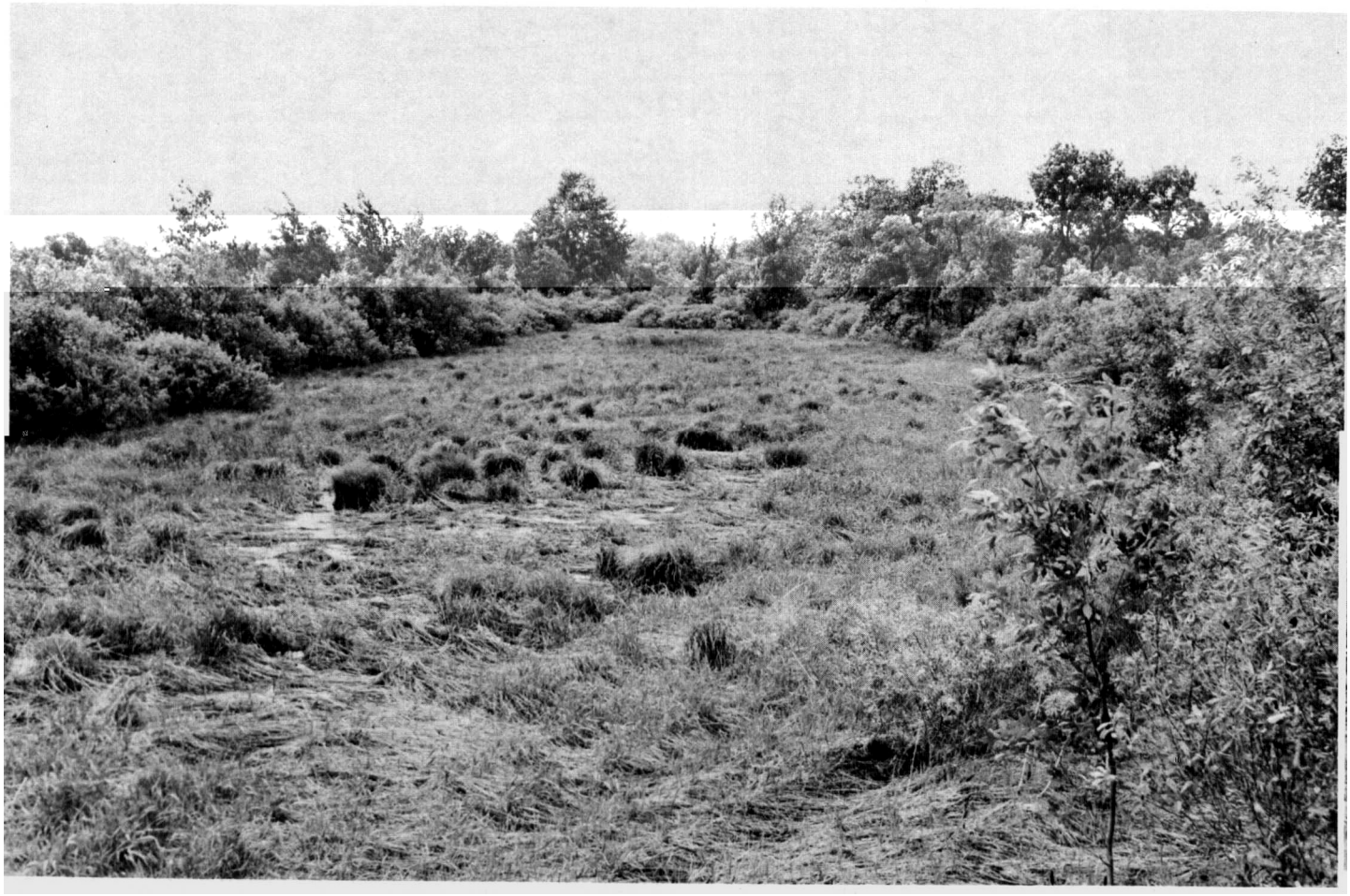


***Figure 3.*—A typical landscape of the Carbondale-Keowns-Cathro association, which is suited to wildlife habitat.**

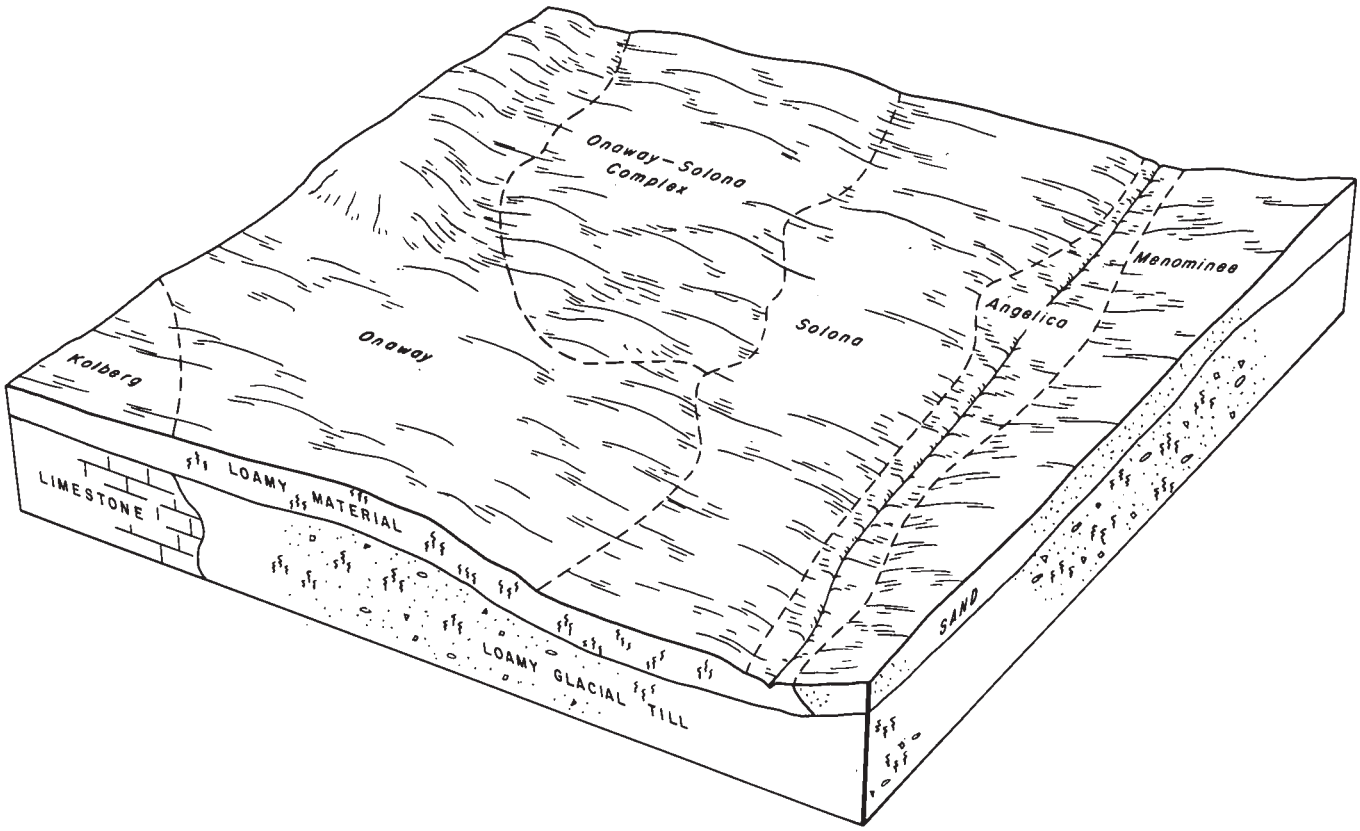



*Figure 4.*—**Relationship of landscape and underlying material to soils in association 5.**

num moss. The major soils in this association have severe limitations for most nonfarm uses.

### *4. Shiocton-Nichols association*

*Somewhat poorly drained and moderately well drained, nearly level and gently sloping, medium textured and moderately coarse textured, moderately permeable soils that are underlain mainly by calcareous silt and very fine sand*

This association consists of nearly level and gently sloping soils in relatively flat old glacial lake basins and on river bottom land. It makes up about 12 percent of the county. It is about 40 percent Shiocton soils, 20 percent Nichols soils, and 40 percent minor soils.

Shiocton soils are somewhat poorly drained and nearly level and gently sloping. They are in lacustrine basins. The surface layer is silt loam. The subsoil is silt loam and very fine sandy loam. The substratum is stratified silt and very fine sand to a depth of about 60 inches. Shiocton clayey substratum soils are underlain by clay at a depth of 40 to 60 inches.

Nichols soils are moderately well drained and nearly level and gently sloping. They are on glacial lake plains. The surface layer and subsoil are very fine sandy loam. The substratum is stratified silt and very fine sand to a depth of about 60 inches. Nichols clayey substratum soils are underlain by clay at a depth of 40 to 60 inches.

Minor soils in this association are Grays, Keowns, and Mundelein soils. The poorly drained Keowns soils are in low-lying depressions. The somewhat poorly drained Mundelein soils are intermingled with Shiocton soils. The moderately well drained and well drained Grays soils are intermingled with Nichols soils.

Corn, small grain, hay crops and specialty crops, such as cabbage and cauliflower, grow well on the soils of this association. Fertility and available water capacity are moderate. The main concerns of management are improving drainage, maintaining fertility, and protection from periodic floods.

Most of this association is used for cultivated crops, but wet soils remain in woodland and are used for wildlife habitat. The main enterprises are dairy farming and the growing of cash crops. The major soils of this association have severe limitations for most nonfarm uses.

### *5. Onaway-Solona association*

*Well drained to somewhat poorly drained, nearly level to moderately steep, medium textured, moderately permeable soils that are underlain by calcareous loam or sandy loam glacial till*

This association consists of nearly level to moderately steep soils on glacial till plains. It makes up about 12 percent of the county. It is about 50 percent Onaway soils, 30 percent Solona soils, and 20 percent minor soils (fig. 4).

Onaway soils are well drained and gently sloping to moderately steep. They are on till plains. The surface layer is loam. The subsoil is fine sandy loam and clay loam. The substratum is loam to a depth of about 60 inches.

Solona soils are somewhat poorly drained and nearly level and gently sloping. They are on till plains. The surface layer is silt loam, and the subsoil is loam. The substratum is loam to a depth of about 60 inches.

Minor soils in this association are Angelica, Kolberg, and Menominee soils. The poorly drained Angelica soils are in low-lying potholes and drainageways. Menominee soils are in areas where there is a sandy overburden. Kolberg soils are in areas where limestone bedrock is at a moderate depth.

Most of the crops commonly grown in the county do well on soils of this association. Fertility and available water capacity are moderate. The main concerns of management are controlling erosion and removing excess water from depressional areas.

Most of this association is used for crops, but many areas are used for permanent pasture or remain in woodland. The soils are very productive for woodland crops. The major enterprise is dairy farming. The major soils in this association have severe limitations for septic tank absorption fields and many other nonfarm uses.

### 6. *Menominee-Grays-Rousseau association*

*Well drained and moderately well drained, nearly level to sloping, coarse textured and medium textured, moderately permeable to rapidly permeable soils that are underlain by lacustrine silt loam and very fine sand, windblown fine sand, or sandy loam glacial till*

This association consists of nearly level soils in glacial lake basins or on outwash plains and of gently sloping to steep soils on outwash ridges or glacial till plains. It makes up about 8 percent of the county. It is about 20 percent Menominee soils, 10 percent Grays soils, 10 percent Rousseau soils, and 60 percent minor soils.

Menominee soils are well drained and gently sloping and sloping and are on till plains. The surface layer is loamy fine sand. The subsoil is fine sand in the upper part and clay loam in the lower part. The substratum is sandy loam to a depth of about 60 inches.

Grays soils are well drained and moderately well drained and nearly level and gently sloping. They are in glacial lake basins. The surface layer is silt loam. The subsoil is silty clay loam and silt loam. The substratum, to a depth of about 60 inches, is silt loam and very fine sand.

Rousseau soils are well drained and moderately well drained and gently sloping. They are in lacustrine basins greatly. Some of the soils are well suited to all crops commonly grown in the county; others are better suited to woodland or wildlife habitat. Fertility and available water capacity range from low to high. The main concerns of management are controlling erosion and soil blowing, removing excess water, and conserving soil moisture.

Much of this association borders and is farmed along with the well defined, more uniform associations of the county. The well drained soils that remain in woodland are commonly used for rural home development, for which they have only slight or moderate limitations. The sandier soils are a good source of sand and gravel.

### 7. *Wainola-Deford-Rousseau association*

*Poorly drained to well drained, nearly level and gently sloping, coarse textured, rapidly permeable soils that are underlain by windblown fine sand or lacustrine fine sand*

This association consists of nearly level and gently sloping soils in lacustrine basins and on outwash plains. It makes up about 5 percent of the county. It is about 40 percent Wainola soils, 20 percent Deford soils, 15 percent Rousseau soils, and 25 percent minor soils (fig. 5).

Wainola soils are somewhat poorly drained and nearly level and gently sloping. They are in lacustrine basins and on outwash plains. The surface layer is loamy fine sand, and the subsoil is fine sand. The substratum is fine sand to a depth of about 60 inches.

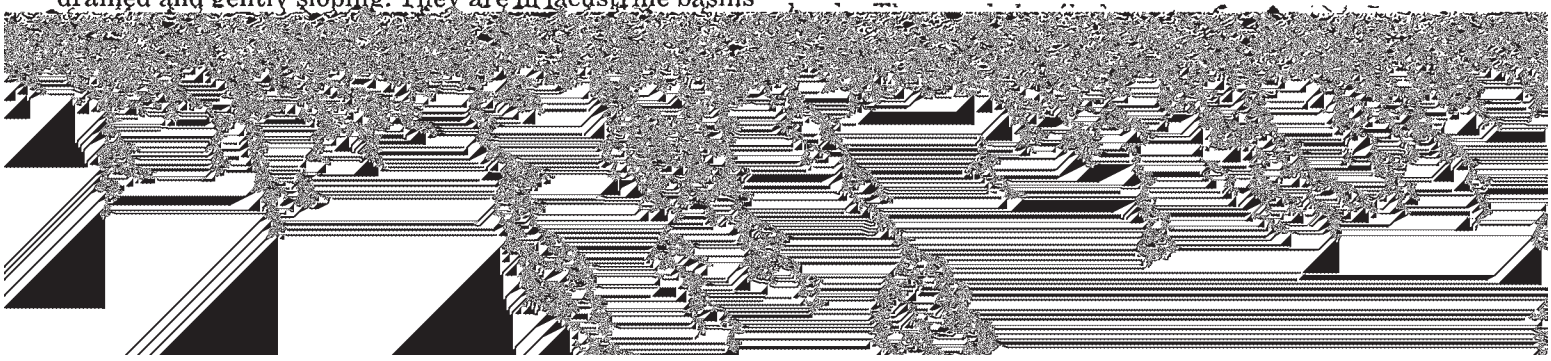
Deford soils are poorly drained and nearly level and are in lacustrine basins. The surface layer is loamy fine sand, and the substratum is fine sand.

Rousseau soils are well drained and moderately well drained and gently sloping. They are in lacustrine basins and on outwash plains. The surface layer is loamy fine sand, and the subsoil is fine sand. The substratum is fine sand to a depth of about 60 inches.

Minor soils in this association are Boyer, Keowns, Markey, and Shawano soils. Keowns soils are intermingled with Deford soils throughout the association. The organic Markey soils are in very poorly drained depressions. Shawano and Boyer soils are scattered throughout the association. Shawano soils formed in windblown sandy deposits and Boyer soils formed in outwash deposits on ridges.

Corn and small grain are grown in areas that are drained. Specialty crops, such as cabbage and cauliflower, do well on the nearly level, somewhat poorly drained soils. The main concerns of management are removing excess water and protecting the soil from blowing. The better drained soils are droughty.

Most of this association remains in woodland or wet-



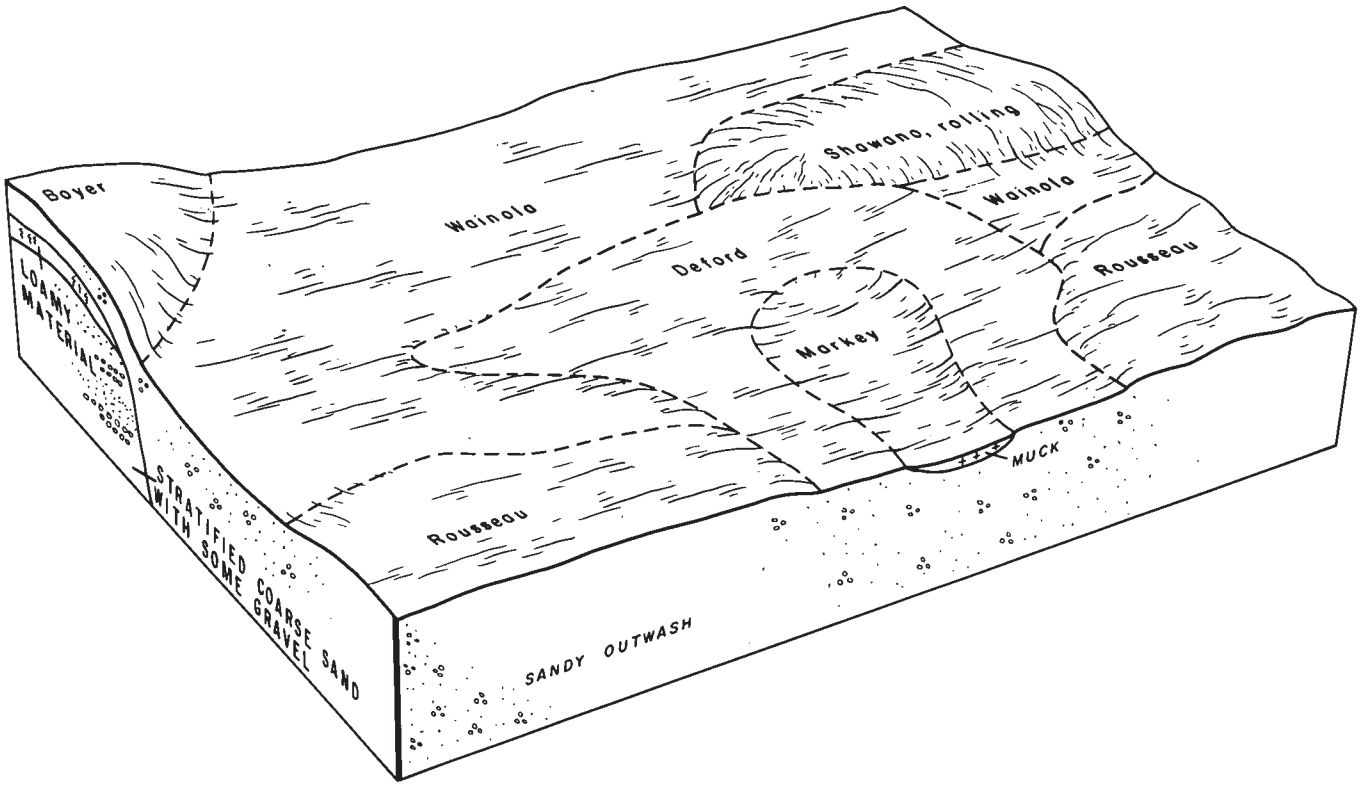



*Figure 5.*—**Relationship of landscape and underlying material to soils in association 7.**

Most mapping units include small, scattered areas of soils other than those that appear in the name of the mapping unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and manage-

structure; very friable; many roots; black (10YR 2/1) coatings on vertical faces of peds; slightly acid; clear smooth boundary.

B2hir—11 to 32 inches; dark yellowish brown

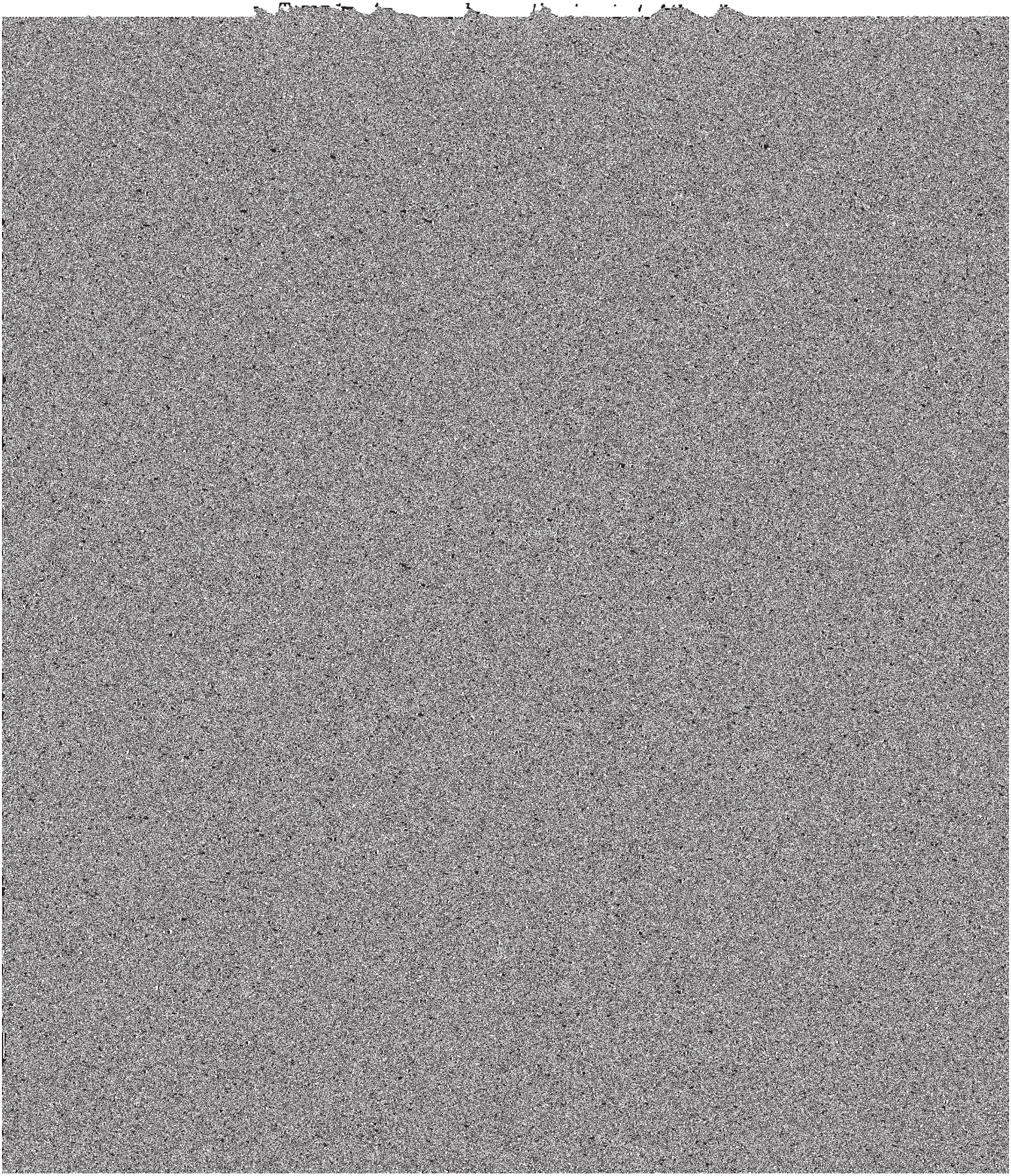


TABLE 1.—*Acreage and proportionate extent of the soils*—Continued

| Map symbol | Soil name | Acres | Percent | Map symbol | Soil name | Acres | Percent |
|---|---|---|---|---|---|---|---|
| WnA | Winneconne silty clay loam, 0 to 2 percent slopes | 6,600 | 1.6 | ZtA | Zittau silty clay loam, 0 to 3 percent slopes | 1,100 | 0.3 |
| WnB | Winneconne silty clay loam, 2 to 6 percent slopes | 12,500 | 3.1 | | Water | 4,441 | 1.1 |
| WnC2 | Winneconne silty clay loam, 6 to 12 percent slopes, eroded | 720 | 0.2 | | Total | 406,016 | 100.0 |

[1] Less than 0.1 percent.

Most areas of this soil are used for crops or pasture, and some areas remain in woodland. This soil is suited to corn, oats, and water-tolerant grasses and legumes. Capability unit IIIw-6; woodland group 2w

C—29 to 60 inches; reddish brown (5YR 5/4) loam; common medium distinct pinkish gray (7.5YR 6/2) and strong brown (7.5YR 5/6) mottles; massive; firm;

Most areas of these soils are used for permanent pasture, and some are cultivated.

Representative profile of Bellevue silt loam, on uncultivated river bottom land 1,410 feet east and 2,530 feet north of the southwestern corner of sec. 32, T. 22 N., R. 19 E.

A1—0 to 12 inches; dark brown (7.5YR 3/2) silt loam; moderate fine granular structure; very friable; many roots; mildly alkaline; clear smooth boundary.

B2—12 to 28 inches; dark reddish brown (5YR 3/4) heavy loam, light brown (7.5YR 6/4) dry; weak medium subangular blocky structure; very friable; many roots; few dark brown (7.5YR 4/4) sand lenses; weakly stratified; mildly alkaline; gradual smooth boundary.

B3—28 to 35 inches; reddish brown (5YR 4/4) silt loam; weak medium and coarse subangular blocky structure; very friable; few roots, weakly stratified; mildly alkaline; gradual smooth boundary.

C1—35 to 50 inches; reddish brown (5YR 4/4) heavy sandy loam; massive; very friable; weakly stratified; moderately alkaline;

In a representative profile the surface layer is black silt loam about 7 inches thick. The subsurface layer is grayish brown mottled silt loam about 3 inches thick. The subsoil is brown mottled loam about 14 inches thick. Light gray consolidated limestone bedrock extends to a depth of about 60 inches or more.

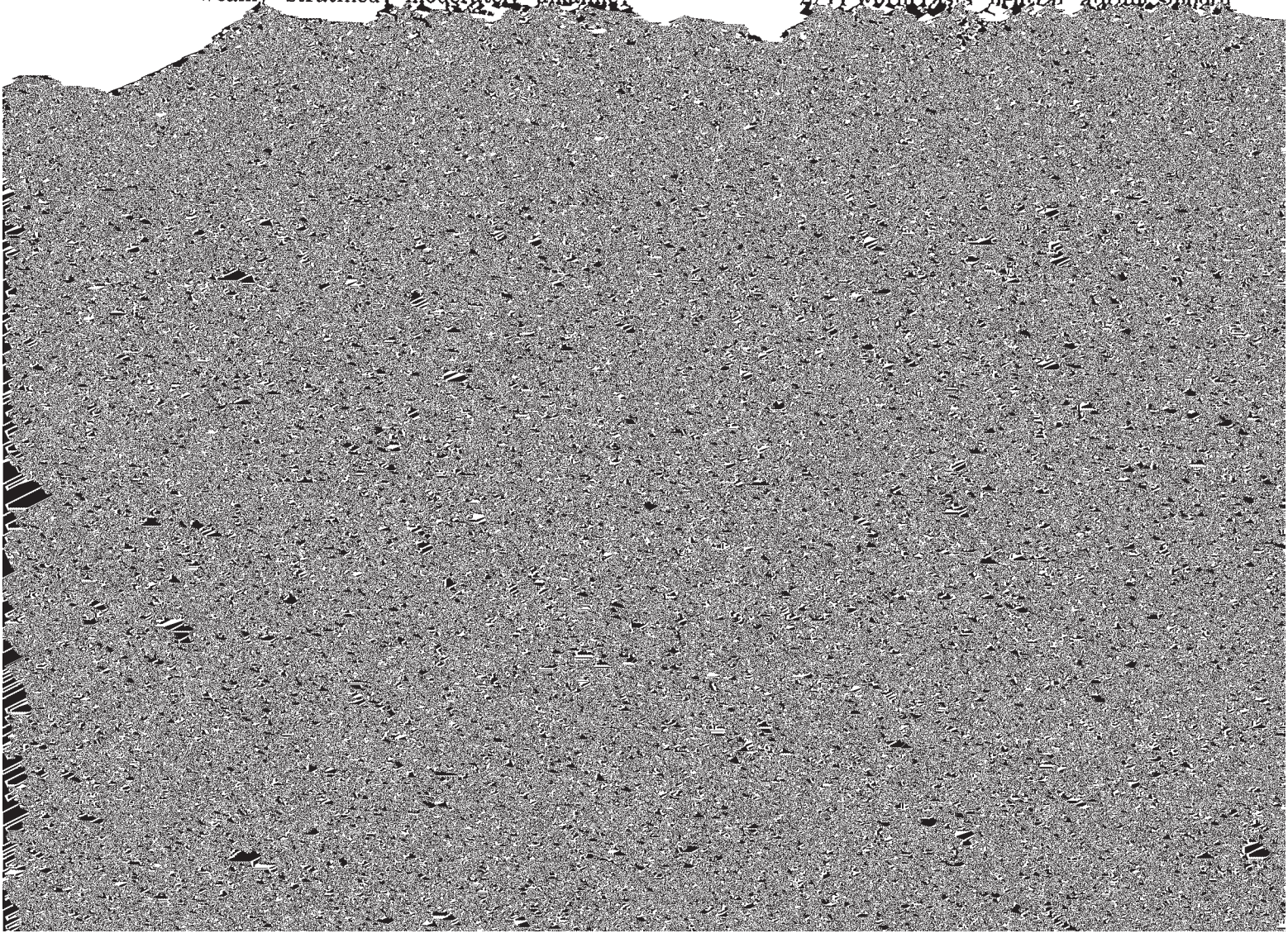
Bonduel soils have low available water capacity and moderate permeability.

Most areas of these soils are cultivated and used for all crops commonly grown in the county.

Representative profile of Bonduel silt loam, 0 to 3 percent slopes, in a woodlot 1,056 feet south and 2,560 feet west of the northeastern corner of sec. 17, T. 21 N., R. 16 E.

A1—0 to 7 inches; black (10YR 2/1) silt loam; moderate fine granular structure; very friable; many roots; neutral; clear smooth boundary.

A2—7 to 10 inches; grayish brown (10YR 5/2) silt loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak thin platy structure parting to moderate fine subangular blocky; very friable; many roots; few fine prominent black (10YR 2/1) worm casts; neutral; abrupt smooth

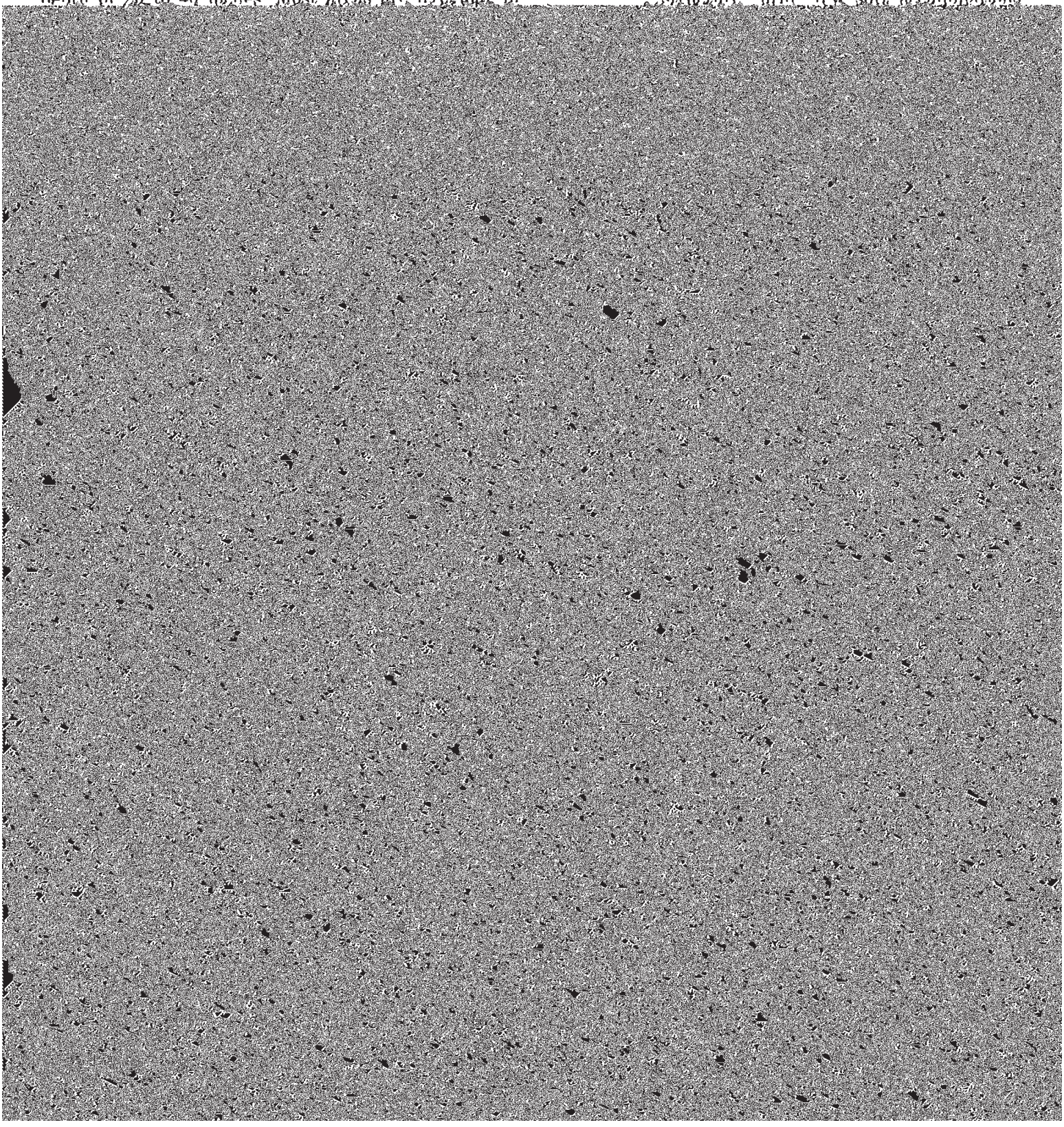


Manawa soils. They are underlain by limestone bedrock that Manawa and Symco soils lack.

**BnA—Bonduel silt loam, 0 to 3 percent slopes.** This nearly level and gently sloping soil is on glacial till plains which are underlain by limestone bedrock at a depth of 20 to 40 inches. Most areas are irregular in

structure; firm; few thin patchy clay films on faces of peds; neutral; clear wavy boundary.

B3—29 to 33 inches; reddish brown (5YR 4/3) silty clay; weak fine subangular blocky structure; firm; few soft accumulations



percent slopes, in a cultivated field 1,050 feet north and 100 feet east of the southwestern corner of sec. 15, T. 22 N., R. 15 E.

Ap—0 to 7 inches; brown (10YR 4/3) loamy sand; weak medium granular structure; very friable; few roots; neutral; abrupt smooth boundary.

B1—7 to 14 inches; brown (7.5YR 5/4) loamy sand; weak medium subangular blocky structure; very friable; neutral; clear wavy boundary.

B2t—14 to 28 inches; reddish brown (5YR 4/4) sandy loam; moderate medium subangular blocky structure; very friable; clay bridging between sand grains; slightly acid; abrupt wavy boundary.

IIC—28 to 60 inches; brown (7.5YR 4/4) coarse sand; single grained; loose; slightly acid.

The solum is 20 to 30 inches thick. It ranges from medium acid to neutral, and the substratum ranges from slightly acid to neutral.

The A horizon is dark grayish brown, very dark grayish brown, or dark brown. The B horizon is dominantly sandy loam or light sandy clay loam but includes thin horizons of loamy sand. The C horizon is typically medium and coarse sand but ranges to fine gravel and coarse sand. In some places there is a ¼- to 1-inch band of loamy sand in the C horizon.

In most areas these soils lack free carbonates in the IIC horizon, and they contain less coarse material than is common for the series. These differences do not some very small areas of soils that have a clayey substratum.

This soil has low natural fertility and low organic-matter content. Effective root penetration is limited by the depth to sand. Runoff is slow. This soil is moderately droughty and is subject to soil blowing. Erosion is a moderate hazard. Practices such as minimum tillage, using shelterbelts, plowing under organic matter, and proper fertilization help control erosion.

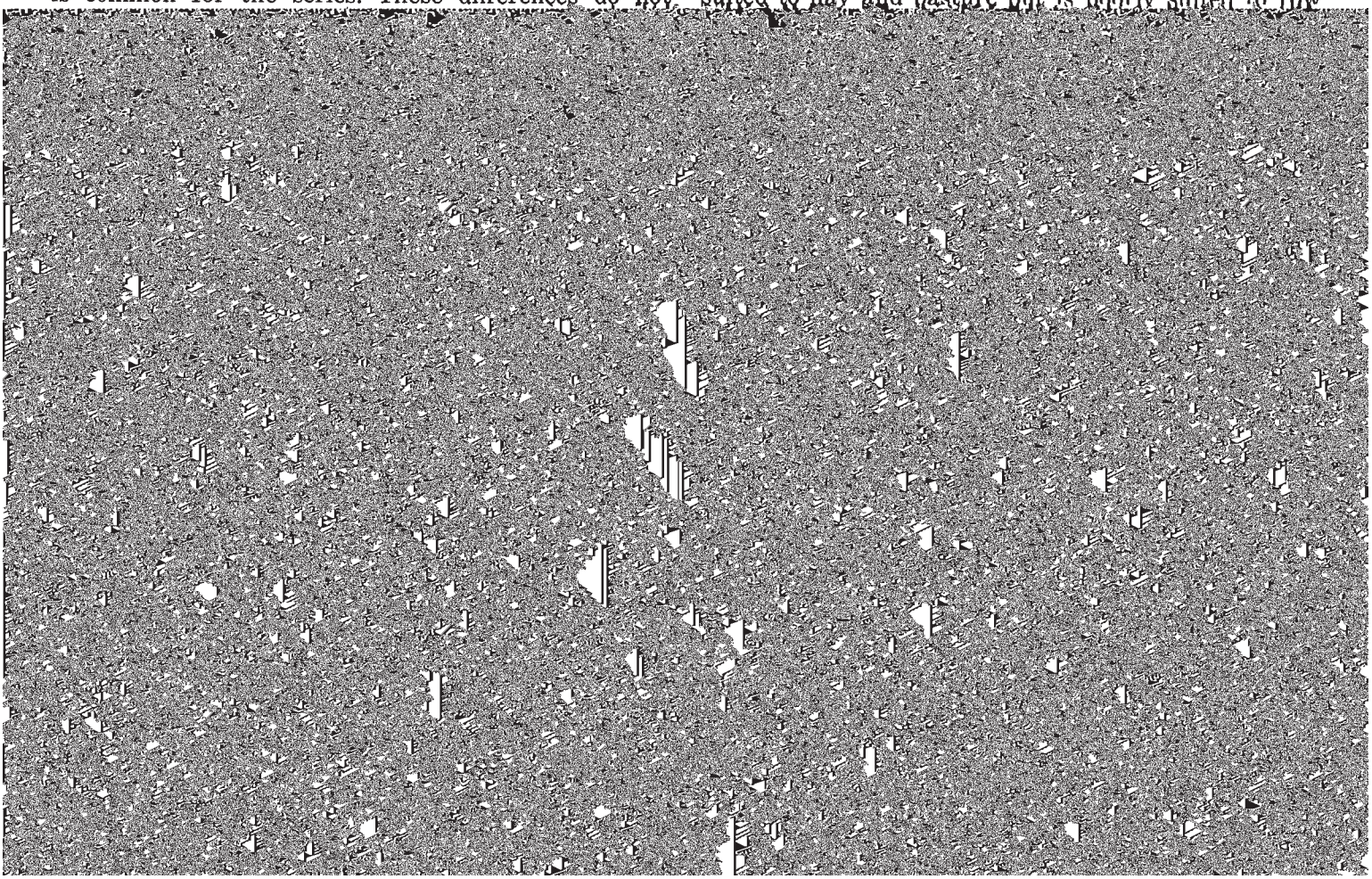
Most areas of this soil are used for small grain and hay, but some are in permanent pasture or woodland. This soil is suited to most crops commonly grown in the county. Capability unit IIIe–7; woodland group 2s.

**BrD2—Boyer loamy sand, 12 to 20 percent slopes, eroded.** This moderately steep soil is on hillsides on outwash ridges. Most areas are long and narrow and range from 3 to 30 acres in size. This soil has a thinner surface layer and subsoil than the soil described as representative of the series.

Included with this soil in mapping are small areas of Casco and Shawano soils. Also included are some severely eroded areas of Boyer soils.

This soil has low natural fertility and low organic-matter content. The effective root zone is limited by the depth to sand. Runoff is medium. This soil is moderately droughty and subject to blowing. Erosion is a severe hazard. Maintaining a good cover crop is necessary to control erosion.

Most areas of this soil are in permanent pasture or woodland, but some are used for crops. This soil is suited to hay and pasture but is poorly suited to row



blocky structure; firm; thin patchy clay films; medium acid; many roots; clear smooth boundary.

B2t—15 to 21 inches; brown (7.5YR 4/4) silty clay; moderate medium subangular blocky structure; firm; medium continuous clay films; medium acid; few roots; clear smooth boundary.

B3t—21 to 27 inches; brown (7.5YR 4/4) silty clay; weak medium subangular blocky structure; firm; thin patchy clay films; slightly acid; few roots; gradual smooth boundary.

C—27 to 60 inches; brown (7.5YR 4/4) silty clay loam; massive; firm; evidence of platiness due to original deposition; slight effervescence; mildly alkaline.

The solum is generally 24 to 32 inches thick, but ranges from 24 to 40 inches. The A horizon is strongly acid or medium acid. The B horizon is slightly acid to moderately alkaline. The C horizon is mildly alkaline or moderately alkaline.

The Ap or A1 horizon is black, very dark grayish brown, or very dark brown and ranges from 4 to 9 inches in thickness. In some places, the C horizon is stratified with silt loam. It has slight or strong effervescence in solution with hydrochloric acid.

Briggsville soils are near Hebron and Mosel soils. They contain more clay than Hebron and Mosel soils and are better drained than Mosel soils.

**BtA—Briggsville silt loam, 0 to 2 percent slopes.** This nearly level soil is on lacustrine plains. Areas are irregular in shape and range from 5 to 240 acres in size. This soil has a thicker surface layer than the soil described as representative of the series.

Included with this soil in mapping are a few areas of gently sloping Briggsville soils and small areas of Manawa soils.

This soil has high natural fertility and low organic-matter content. The effective root zone is deep. Runoff is slow. This soil is relatively easy to maintain in good tilth.

Most of this soil is used for crops. It is well suited to all crops commonly grown in the county. Capability unit IIs–7; woodland group 2c.

**BtB—Briggsville silt loam, 2 to 6 percent slopes.** This gently sloping soil is on lacustrine plains. Most areas are irregular in shape and range from 5 to 320 acres in size. This soil has the profile described as representative of the series.

## Carbondale Series

The Carbondale series consists of very poorly drained, nearly level, organic soils in large basins or glacial depressions. These soils formed under a mixed forest of white-cedar, tamarack, and soft maple in highly decomposed herbaceous organic deposits.

In a representative profile the organic layer is more than 60 inches thick. It is black and very dark brown muck in about the upper 34 inches, very dark brown peaty muck in the middle 22 inches, and very dark brown muck with bands of dark gray marl in the lower part.

Carbondale soils have very high available water capacity. Permeability is moderately slow in the upper part and moderate to moderately rapid in the lower part.

Most of these soils are undrained and remain in woodland. Drained areas are used mainly to grow specialty crops.

Representative profile of Carbondale muck, in a woodlot 100 feet north and 1,520 feet east of the southwestern corner of sec. 10, T. 24 N., R. 17 E.

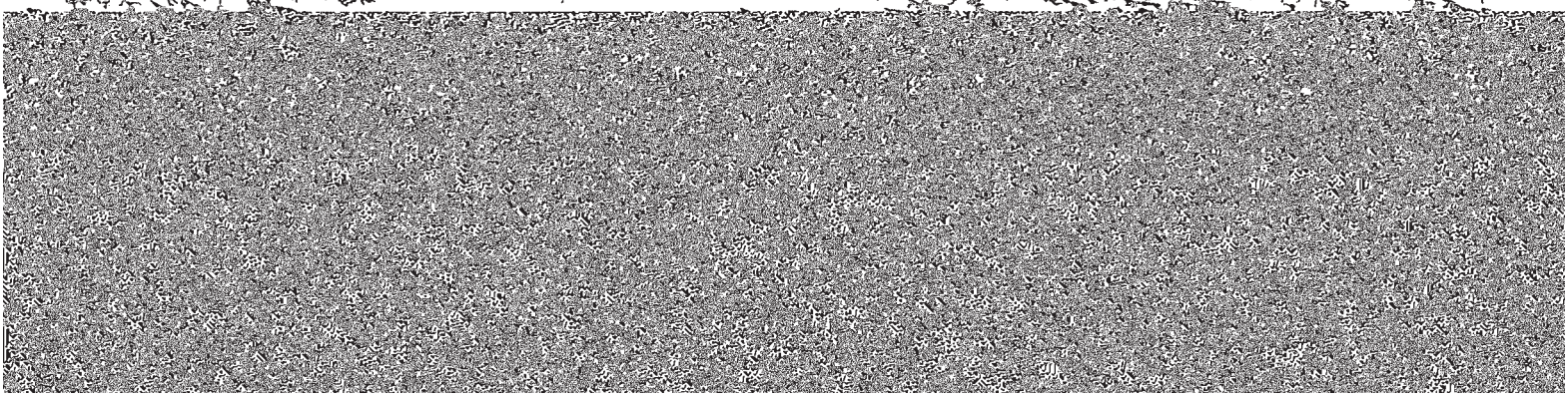
Oa1—0 to 10 inches; black (10YR 2/1) broken face and rubbed sapric material; less than 5 percent fiber, a trace when rubbed; moderate fine granular structure; nonsticky; predominantly herbaceous fibers; neutral; clear smooth boundary.

Oa2—10 to 34 inches; very dark brown (10YR 2/2) broken face and rubbed sapric material; less than 5 percent fiber, a trace when rubbed; moderate fine granular structure; nonsticky; predominantly herbaceous fibers; neutral; abrupt smooth boundary.

Oe—34 to 56 inches; very dark brown (10YR 2/2) broken face and rubbed hemic material; about 30 percent fiber, about 20 percent rubbed; weak fine granular structure; nonsticky; predominantly herbaceous fibers; slightly acid; clear smooth boundary.

Oa3—56 to 60 inches; very dark brown (10YR 2/2) broken face and rubbed sapric material; less than 5 percent fiber, a trace when rubbed; massive; bands of dark gray (5Y 4/1) marl up to 2 inches thick throughout; nonsticky; predominantly herbaceous fibers; neutral.

The organic deposits are more than 51 inches thick



soils are less acid and have a lower fiber content than Lobo soils.

**Ca—Carbondale muck.** This is a nearly level soil in wet positions along lakes or stream valleys and pockets on till plains. Areas are irregular in shape and range from 3 to 1,280 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are small areas of shallower organic soils. Also included are some areas that have a higher fiber content than is typical of the series, and some gently sloping Carbondale soils.

This soil has low natural fertility and very high organic-matter content. The effective rooting depth is limited by the water table. Runoff is very slow to ponded. Ponding of water occurs frequently because the water table is at or near the surface. Drained areas are subject to soil blowing and burn easily. There is a hazard of frost damage to crops that are grown on this soil. Open-ditch drainage or tile drainage can be used to remove excess water.

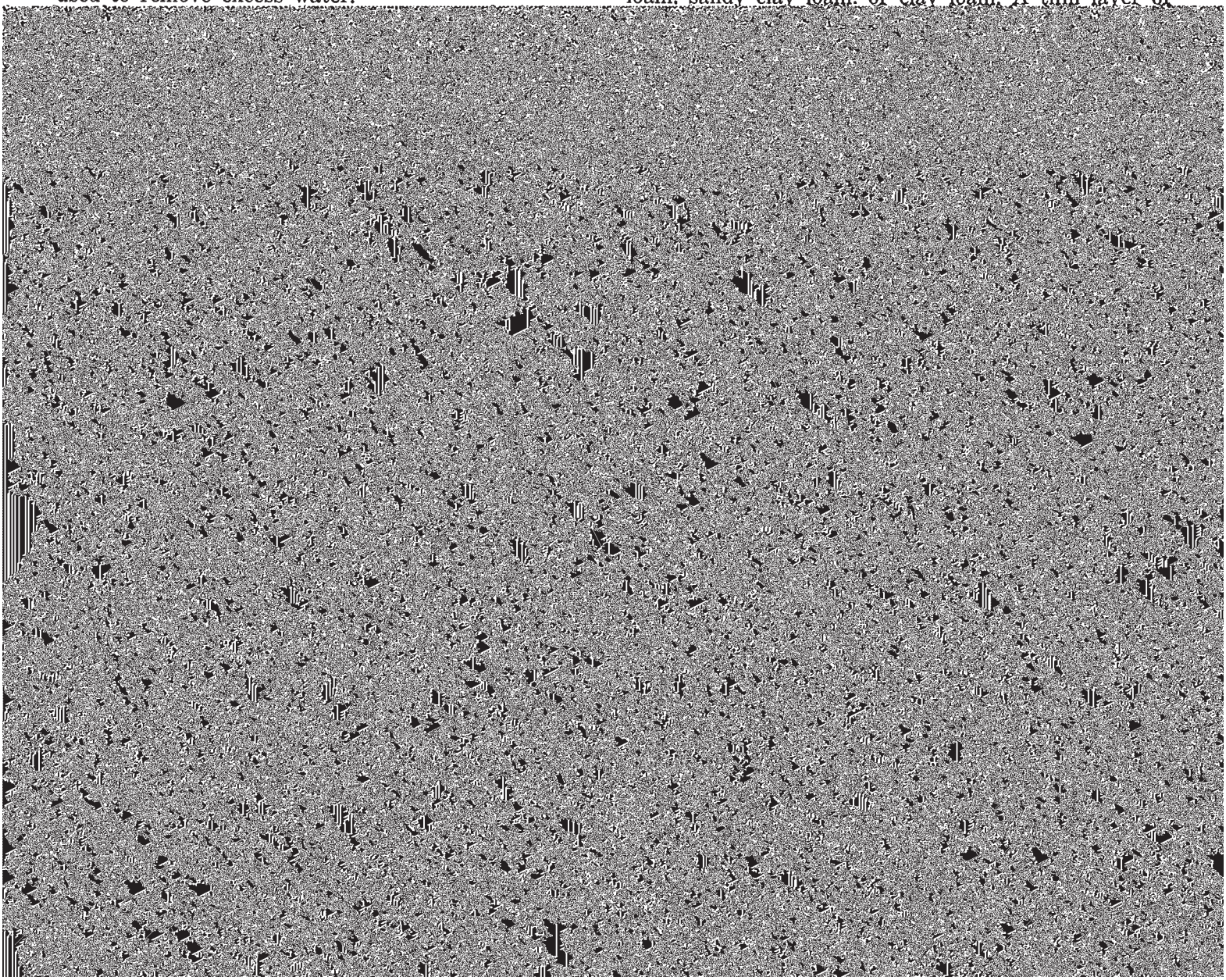
tinuous clay films on faces of peds; neutral; clear wavy boundary.

IIB3t—15 to 19 inches; reddish brown (5YR 4/4) light sandy loam; weak medium subangular blocky structure; very friable; many roots; clay bridging; about 25 percent coarse sand and gravel; mildly alkaline; clear wavy boundary.

IIC—19 to 60 inches; yellowish brown (10YR 5/4) sand and gravel; single grained; loose; violent effervescence; moderately alkaline.

The solum is 10 to 20 inches thick. Some profiles have 15 to 25 percent gravel in the solum. The A horizon is medium acid to neutral, the B horizon is medium acid to mildly alkaline, and the C horizon is mildly alkaline or moderately alkaline.

The A horizon is black or very dark grayish brown and typically is 3 to 5 inches thick. The B horizon is loam, sandy clay loam, or clay loam. A thin layer of



**CcD2—Casco loam, 12 to 20 percent slopes, eroded.** This moderately steep soil is on morainic ridges. Most areas are long and narrow and range from 3 to 40 acres in size. This soil has a thinner solum than the soil described as representative of the series.

Included with this soil in mapping are small areas of sloping Casco soils and a few areas that are severely eroded.

This soil has low natural fertility and low organic-matter content. The effective rooting depth of many crops is limited by the underlying sand and gravel. Runoff is rapid. Erosion is a severe hazard, and drought is a moderate hazard.

Most areas of this soil remain in woodland or permanent pasture. The substratum is a good source of sand and gravel. Capability unit VIe–3; woodland group 3s.

## Cathro Series

The Cathro series consists of nearly level, very poorly drained organic soils in glacial lake basins and depressions on lacustrine plains. These soils formed under mixed vegetation of white-cedar, aspen, and soft maple in highly decomposed organic deposits underlain by mildly alkaline loamy material.

In a representative profile the organic layer is very dark brown and black muck about 33 inches thick. The substratum is dark grayish brown silt loam to a depth of about 60 inches.

Cathro soils have very high available water capacity. Permeability is moderately slow to moderately rapid in the muck and moderate to moderately slow in the silt loam.

Most areas of these soils are undrained and remain in woodland. Drained areas are used mainly for specialty crops.

Representative profile of Cathro muck, in marsh 150 feet north and 150 feet east of the southwestern corner of sec. 29, T. 24 N., R. 16 E.

Oa1—0 to 4 inches; very dark brown (10YR 2/2) broken face and rubbed sapric material; less than 5 percent fiber, a trace when rubbed; moderate medium granular structure; nonsticky; primarily herbaceous fibers; many roots; slightly acid; abrupt smooth boundary.

Oa2—4 to 16 inches; black (10YR 2/1) broken face and rubbed sapric material; less than 5 percent fiber, a trace when rubbed; moderate medium granular structure; nonsticky; primarily herbaceous fibers; few

generally composed of sapric material; but some thin bands, 1 to 4 inches thick, of hemic material occur throughout the profile in places. Thin layers of sedimentary peat are in some pedons. The organic material is medium acid to mildly alkaline. The IIC horizon is neutral to moderately alkaline. It is sandy loam, loam, or silt loam, but includes thin layers of fine sand and silty clay loam.

Cathro soils are near Carbondale, Lobo, Markey, Rondeau, and Suamico soils. They lack the thick organic deposits that Carbondale and Lobo soils have. Cathro soils are underlain by loamy material, Markey soils are underlain by sand, Rondeau soils are underlain by marl, and Suamico soils are underlain by clay.

**Cm—Cathro muck.** This is a nearly level soil in shallow glacial lake basins and depressions. Areas are irregular in shape and range from 5 to 640 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are areas of Carbondale, Keowns, and Pella soils. Also included are some small areas where marl overlies the loamy material.

This soil has low natural fertility and very high organic-matter content. The effective rooting depth is limited by the high water table or, in drained areas, by the loamy substratum. Runoff is very slow to ponded. Wetness is a severe hazard. Open-ditch drainage can be used to remove excess water. This soil subsides if it is drained and it becomes very susceptible to soil blowing and burning where water levels are not properly maintained. There is a hazard of frost damage to crops grown on this soil.

Most areas are undrained and are used for pasture or woodland. Drained areas are used for growing truck crops or sod for lawns. This soil is best suited to crops that have a short growing season. It is well suited to wildlife habitat. Capability unit IVw–8; woodland group 3w.

## Channahon Series

The Channahon series consists of gently sloping, well drained soils on glacial till plains. These soils are shallow over limestone bedrock. They formed under vegetation of prairie grasses and scattered bur oak.

In a representative profile the surface layer is very dark brown silt loam about 8 inches thick. The subsoil is about 10 inches thick. It is brown silt loam in the upper part and brown light clay loam in the lower part. Limestone bedrock is at a depth of 18 inches.

Channahon soils have low available water capacity

structure; friable; few roots; many medium very dark grayish brown (10YR 3/2) worm casts; 5 percent stone content; neutral; clear wavy boundary.

B21t—11 to 16 inches; brown (7.5YR 4/4) light clay loam; moderate medium subangular blocky structure; friable; few roots; few medium very dark grayish brown (10YR 3/2) worm casts; 5 percent stone content; thin continuous clay films on faces of peds; neutral; clear wavy boundary.

a pasture 250 feet east and 1,550 feet north of the southwestern corner of sec. 7, T. 24 N., R. 17 E.

O1—5 inches to 0; black (10YR 2/1) broken face and rubbed sapric material with many coarse reddish brown (5YR 4/4) fibers; weak fine granular structure; very friable; about 60 percent fine sand; primarily herbaceous fibers; many roots; slightly acid; clear smooth boundary.

A1—0 to 5 inches; very dark brown (10YR 2/2) loamy fine sand; many fine prominent yel-

mixed hardwoods and some conifers and consisted of maple, oak, hickory, birch, and white pine.

In a representative profile the surface layer is black fine sandy loam about 4 inches thick. The subsurface layer is brown fine sandy loam about 4 inches thick. The subsoil is 21 inches thick. It is yellowish brown

and Kolberg soils are underlain by limestone. Rock outcrop is mostly exposures of limestone bedrock.

**ElB—Eleva fine sandy loam, 2 to 6 percent slopes.** This gently sloping soil occupies sandstone bedrock-controlled uplands. Most areas are long and narrow and range from 2 to 60 acres in size. This soil has a thicker

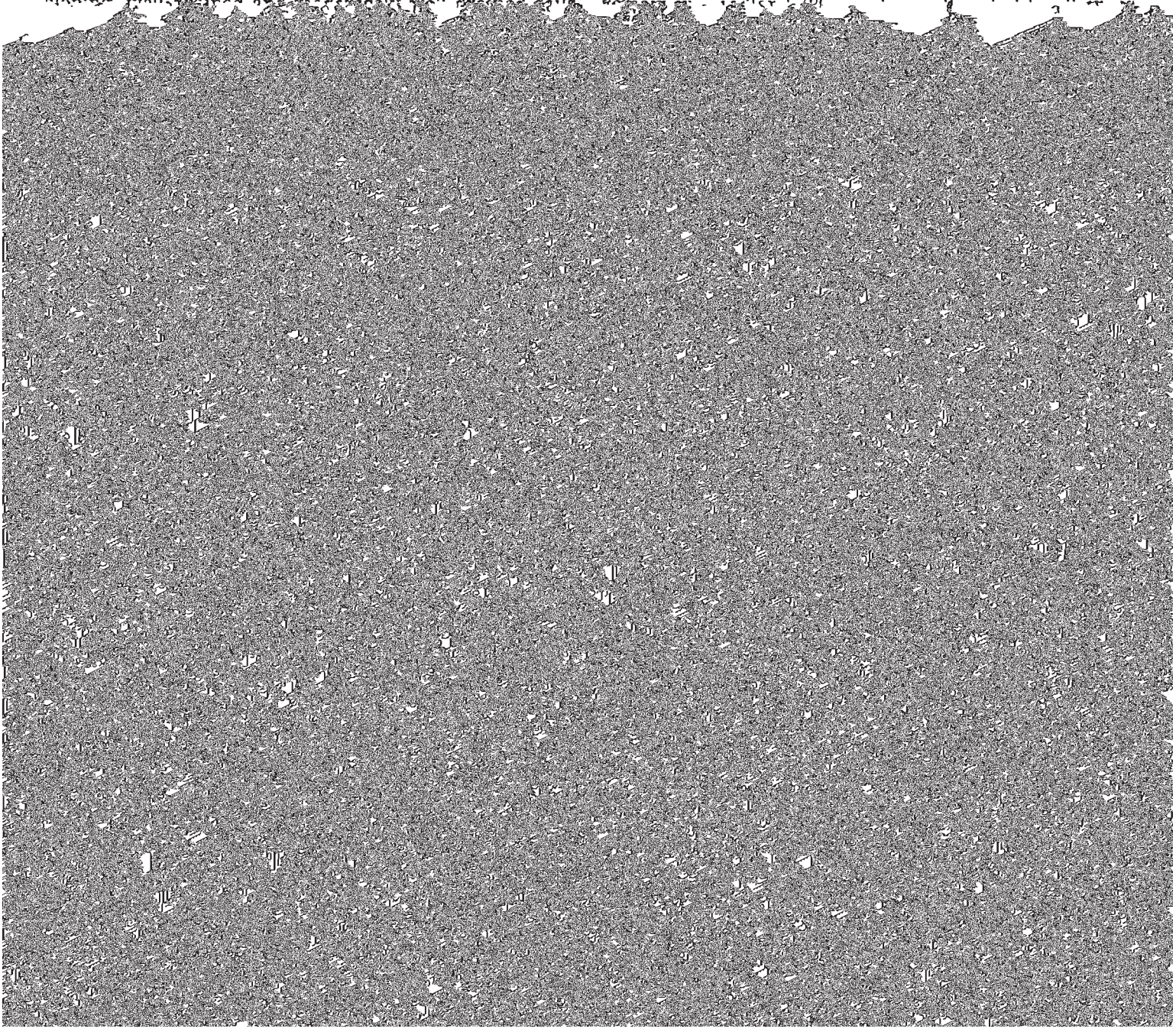
where sand and gravel have been removed to a depth of several feet or more for highway construction and other engineering projects. Most of these gravel pits are in or near areas of Casco and Boyer soils. Most areas are round or rectangular and range from less than 1 acre to about 5 acres in size.

Included in mapping are areas of soil overburden scraped from the pit areas. Gravel pits are not rated for soil properties or any selected use.

In some places Gravel pits are used for recreation areas or wildlife habitat. Not placed in a capability unit or woodland group.

## Grays Series

The Grays series consists of nearly level and gently sloping, well-drained and moderately well drained soils



They are better drained than Mundelein soils and have a finer textured B horizon than Nichols soils.

**GrA—Grays silt loam, 0 to 2 percent slopes.** This nearly level soil is on lacustrine plains. Most areas are irregular in shape and range from 2 to 200 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are a few areas of gently sloping Grays soils and areas where the surface layer is very fine sandy loam. Also included are some small areas of Mundelein and Nichols soils.

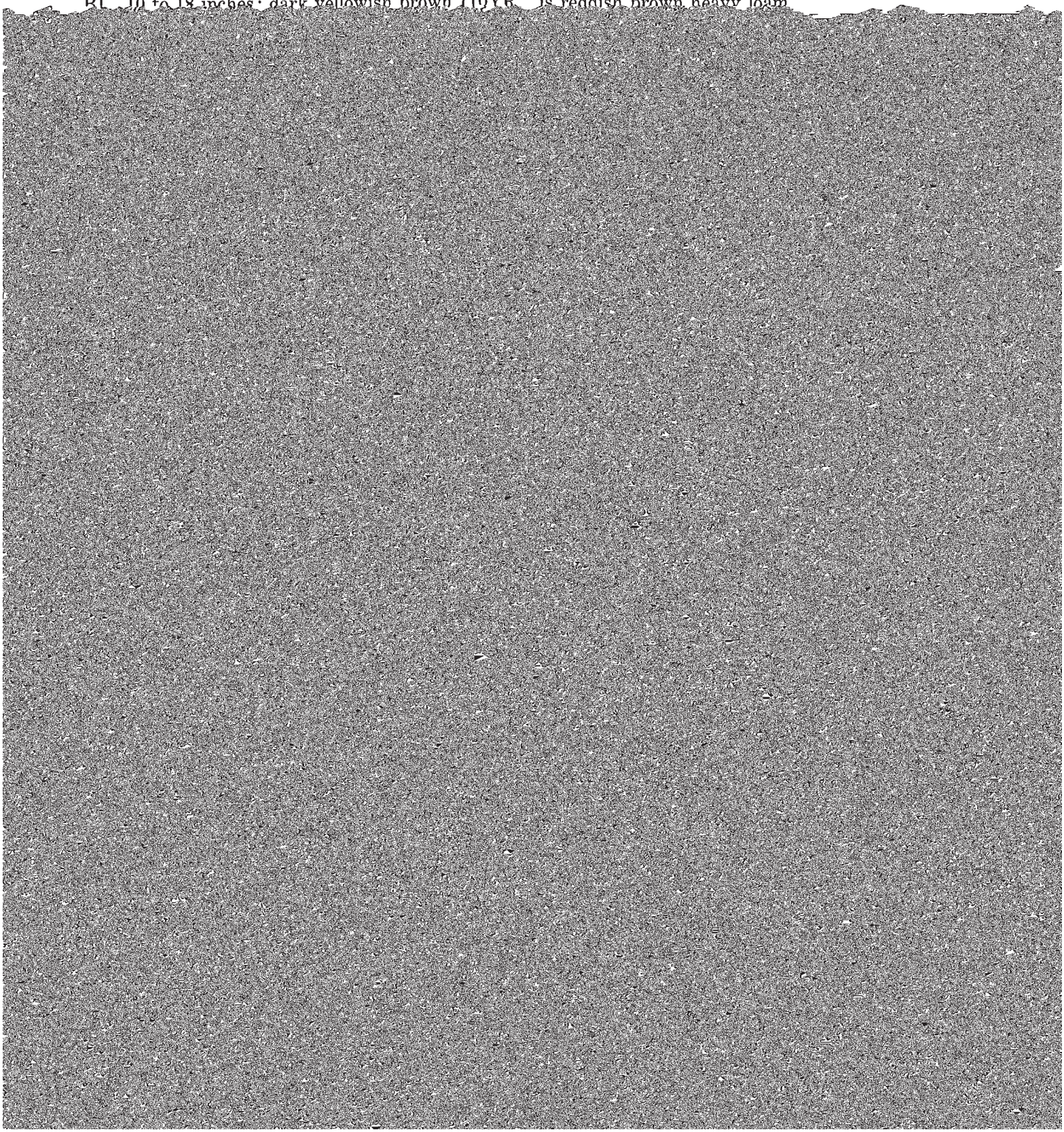
This soil has high natural fertility and moderately low organic-matter content. The effective root zone is deep. Runoff is slow. There are no major management concerns for crop production.

Most areas of this soil are used for crops, and some

4/2) loam; weak medium platy structure; very friable; slightly acid; clear smooth boundary.

B1 10 to 18 inches; dark yellowish brown (10YR

brown silt loam about 9 inches thick. The subsoil is dark reddish brown silty clay loam about 13 inches thick. The substratum to a depth of about 60 inches is reddish brown heavy loam.



Hortonville soils. Also included are some areas that have a loam surface layer and small areas of Menominee soils.

This Hortonville soil has medium natural fertility

in the county. Capability unit IIIe–1; woodland group 1o.

**HrD2—Hortonville silt loam, 12 to 20 percent slopes, eroded.** This moderately steep soil is on glacial till

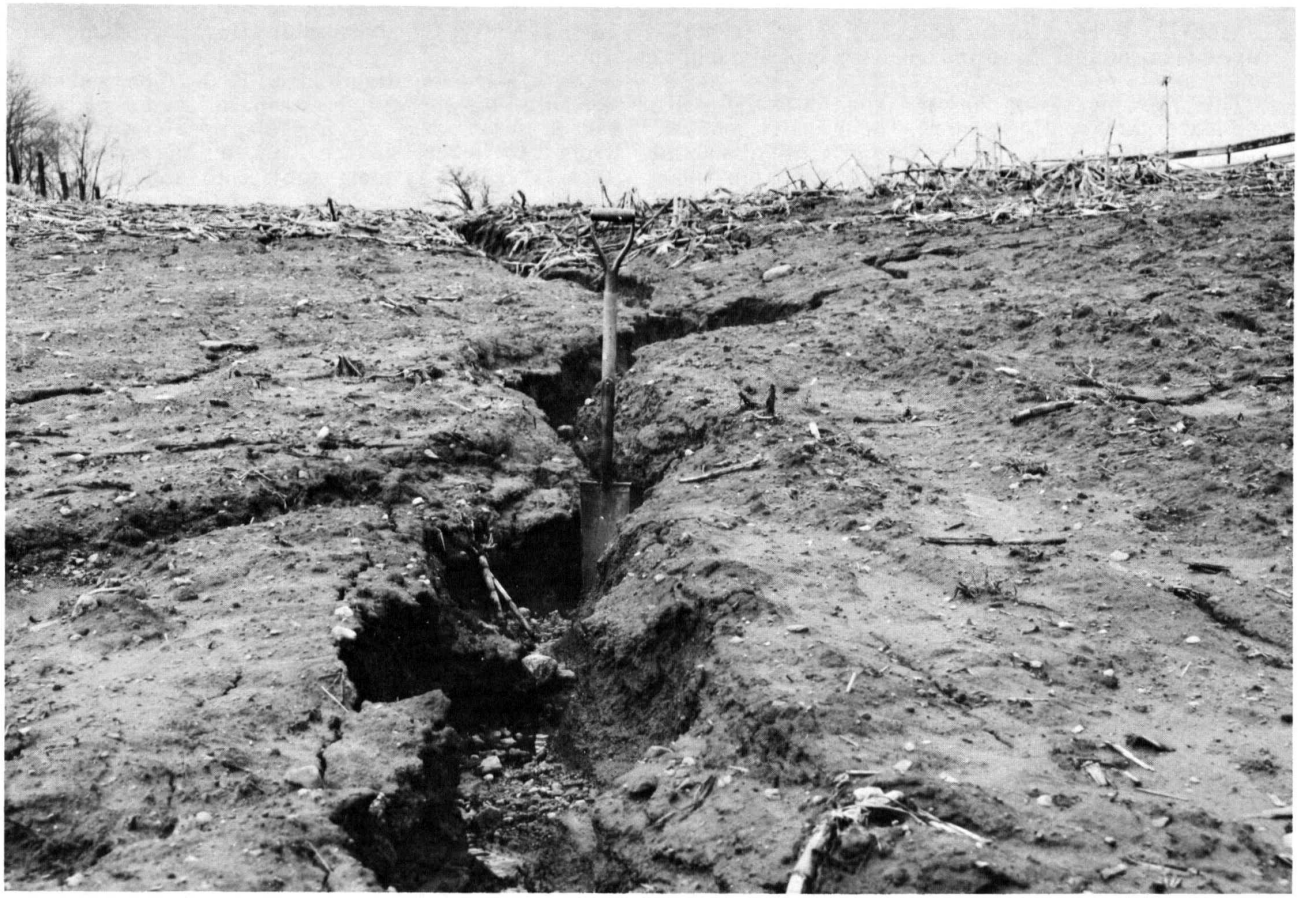


*Figure 6.*—**Cultivation of this area of Hortonville silt loam, 12 to 20 percent slopes, eroded, has led to severe gully erosion. This soil is better suited to pasture and hay crops.**

areas of Hortonville soils that are severely eroded or that do not have a limestone substratum.

This soil has high natural fertility and low organic-matter content. The effective rooting depth is limited by the underlying limestone. Runoff is medium. Erosion is a moderate hazard. Erosion-control practices such as contour stripcropping, grassed waterways, proper crop rotation, and minimum tillage are beneficial where row crops are grown.

Most of this soil is cultivated. It is suited to all crops commonly grown in the county. Capability unit IIIe–1; woodland group 1o.

**HtB—Hortonville-Symco silt loams, 2 to 6 percent slopes.** These gently sloping soils are on glacial till plains. Most areas are irregular in shape and range from 5 to about 200 acres in size. This complex is about 60 percent Hortonville silt loam and 20 percent Symco silt loam. Hortonville soils are on convex side slopes on uplands. Symco soils are in wet drainageways and depressions. Also included are some areas where the surface layer is sandy loam.

Runoff is very slow to medium. Erosion is the main hazard on Hortonville soils and wetness is the main hazard on Symco soils. Management is needed on Hortonville soils to maintain plant cover and to reduce runoff and erosion. Symco soils need drainage for dependable crop production.

Most of this complex is cultivated. Uncultivated areas are mostly Symco soils in woodland or in pasture. If properly managed, the soils in this complex are well suited to all crops commonly grown in the county. Capability unit IIe–1; woodland group 1o.

## Kaukauna Series

The Kaukauna series consists of moderately well drained and well drained, nearly level and gently sloping soils on glacial lake plains. These soils formed under

brown mottled clay in the upper part and brown mottled clay in the lower part. The substratum to a depth of about 60 inches is light brown mottled silt that is stratified with layers of very fine sand.

Kaukauna soils have moderate available water capacity. Permeability is slow in the clayey part and moderate to moderately slow in the loamy part.

Most areas of these soils are cultivated and used for all crops commonly grown in the county.

Representative profile of Kaukauna silty clay loam, 0 to 3 percent slopes, in hayland 1,435 feet east and 1,020 feet south of the northwestern corner of sec. 14, T. 21 N., R. 18 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate very fine granular structure; friable; many roots; neutral; abrupt smooth boundary.

B21t—9 to 18 inches; dark reddish brown (5YR 3/4) clay; strong medium angular blocky structure; very firm; thin continuous clay films on all faces of peds; mildly alkaline; clear smooth boundary.

B22t—18 to 27 inches; dark reddish brown (5YR 3/3) clay; few fine prominent yellowish brown (10YR 5/3) mottles; weak coarse subangular blocky structure; very firm; thin continuous clay films on vertical faces of peds; neutral; clear smooth boundary.

IIB3t—27 to 34 inches; brown (7.5YR 4/4) silt loam; many fine prominent yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; friable; thin patchy clay films on vertical faces of peds; mildly alkaline; clear smooth boundary.

IIC—34 to 60 inches; light brown (7.5YR 6/4) silt with thin layers of very fine sand; common fine prominent yellowish brown (10YR 5/8) mottles; weak thin platy structure; very friable; common fine distinct pinkish gray (7.5YR 7/2) calcium carbonate segregations; violent effervescence; moderately alkaline.

The solum is typically 30 to 40 inches thick. The A horizon is medium acid to mildly alkaline, the B horizon is neutral to moderately alkaline, and the IIC horizon is mildly alkaline or moderately alkaline.

The A horizon is black, dark reddish brown, very dark brown, or very dark grayish brown and is 6 to 10 inches thick. The B horizon is clay or silty clay in the upper part and silt loam, loam, or very fine sandy loam in the lower part. The C horizon is silt that is stratified with thin layers of very fine sand or very fine sandy loam.

Kaukauna soils are near Manawa and Winneconne soils. They have thinner clayey layers than Winneconne soils and are better drained than Manawa soils.

**KaA—Kaukauna silty clay loam, 0 to 3 percent slopes.** This nearly level and gently sloping soil is on glacial lake plains. Most areas are long and narrow and range from 5 to 100 acres in size.

Included with this soil in mapping are areas of Grays and Winneconne soils. Also included are some small areas of wet soils.

Kaukauna soils have high natural fertility and moderately low organic-matter content. The effective root zone is deep. Runoff is slow. Maintaining favorable tilth is difficult, especially if this soil is tilled when wet. However, minimum tillage and plowing under green manure are beneficial.

Most areas of this soil are cultivated. This soil is well suited to all crops commonly grown in the county. Capability unit IIs–7; woodland group 2c.

## Keowns Series

The Keowns series consists of nearly level, poorly drained soils in depressions on glacial lake plains. These soils formed under native vegetation of swamp hardwoods and some prairie grasses.

In a representative profile the surface layer is very dark brown silt loam about 8 inches thick. The subsoil is dark gray mottled fine sandy loam about 13 inches thick. The substratum is dark gray mottled silt and fine sand to a depth of about 60 inches.

Keowns soils have high available water capacity and moderate permeability.

Most areas of this soil are in woodland or pasture. Drained areas are used for crops such as corn and cabbage.

Representative profile of Keowns silt loam, in a woodlot 1,900 feet east and 150 feet north of the southwestern corner of sec. 4, T. 24 N., R. 16 E.

A1—0 to 8 inches; very dark brown (10YR 2/2) silt loam; moderate fine granular structure; very friable; many roots; neutral; abrupt smooth boundary.

Bg—8 to 21 inches; dark gray (5Y 4/1) fine sandy loam; common medium prominent yellowish red (5YR 4/6) mottles; moderate medium subangular blocky structure; friable; many roots; mildly alkaline; gradual smooth boundary.

C1g—21 to 34 inches; dark gray (5Y 4/1) silt and fine sand; common medium prominent yellowish red (5YR 4/6) mottles; weak thin platy structure due to original deposition; massive; mildly alkaline; clear smooth boundary.

C2g—34 to 60 inches; dark gray (5Y 4/1) fine sand; common medium prominent yellowish red (5YR 4/6) mottles; single grained; loose; many coarse prominent very dark brown (10YR 2/2) organic stains; mildly alkaline.

The solum is 15 to 30 inches thick. The A and B horizons are neutral to moderately alkaline, and the C horizon is mildly alkaline or moderately alkaline.

The A1 or Ap horizon is black or very dark brown and is 6 to 10 inches thick. The B horizon is very fine sandy loam, fine sandy loam, sandy loam, or silt loam. The C horizon is typically stratified silt and fine sand, but in places it includes thin layers of silty clay loam.

Keowns soils are near Mundelein and Shiocton soils. They have a lower clay content in the B horizon than Mundelein soils. Keowns soils are wetter than Mundelein and Shiocton soils.

**Ke—Keowns silt loam.** This is a nearly level soil in depressions on lacustrine plains. Most areas are irreg-

ular in shape and range from 2 to 1,200 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are small areas of Cathro, Mundelein, and Shiocton soils. Also included are small areas of soils that contain more silt and clay in the subsoil than Keowns soils.

This soil has high natural fertility and high organic-matter content. The effective rooting depth is limited by the water table. Runoff is very slow to ponded. Wetness is the main limitation of this soil. Open-ditch drainage can be used to remove excess water.

Most areas of this soil are in woodland or pasture, but many are cleared and used for crops. This soil is well suited to wetland tree species and is also suited to crops, such as corn and cabbage, if it is drained. Capability

C—27 to 60 inches; reddish brown (5YR 4/3) light silty clay; strong medium prismatic structure; extremely hard; many coarse prominent light brownish gray (10YR 6/2) calcium carbonate segregations; few coarse pebbles; violent effervescence; moderately alkaline.

The solum is 20 to 40 inches thick. The A and B horizons are medium acid to mildly alkaline and the C horizon is mildly alkaline or moderately alkaline.

The A1 or Ap horizon is dark brown, dark grayish brown, and very dark grayish brown and is 3 to 8 inches thick. The B horizon is clay, heavy silty clay loam, or silty clay. The C horizon is heavy silty clay loam, silty clay, and light clay.

included are some areas where the surface layer is sandy loam.

This soil has high natural fertility and low organic-matter content. The effective root zone is deep. Runoff is rapid. Erosion is a severe hazard. Stripcropping and minimum tillage reduce runoff and help control erosion. This soil has a moderate tilth problem, but green manuring will improve tilth.

Most areas of this soil are used for pasture, and some areas are in woodland. This Kewaunee soil is best suited to hay and pasture. Capability unit IVe–2; woodland group 2c.

**KkE3—Kewaunee soils, 20 to 45 percent slopes, severely eroded.** These steep and very steep soils are on side slopes of till plains along rivers and streams. The surface layer is silty clay loam, clay loam, or clay. Most areas are long and narrow and range from 10 to 200 acres in size. These soils have a thinner surface layer and subsoil than the soil described as representative of the series.

Included with these soils in mapping are small areas of sandy soils. Also included are small areas of soils that are steeper than 45 percent and other areas where slopes are less than 20 percent.

These soils have high natural fertility and low organic-matter content. Runoff is very rapid. Erosion and slippage are vere severe hazards.

Most of these soils are in woodland, but some areas are in pasture. These soils are unsuited to cultivated crops and are poorly suited to pasture. Capability unit VIIe–6; woodland group 2c.

**KlB—Kewaunee-Manawa complex, 2 to 6 percent slopes.** These gently undulating soils are on glacial till plains. Most areas are irregular in shape and range from

In a representative profile the surface layer is very dark brown silt loam about 5 inches thick. The subsoil is about 22 inches thick. It is mostly reddish brown silty clay loam in the upper part, reddish brown clay in the middle part, and reddish brown loam in the lower part. Consolidated limestone bedrock is at a depth of about 27 inches.

Kolberg soils have low available water capacity and moderately slow or slow permeability.

Most areas of these soils are cultivated and are used for all crops commonly grown in the county. Some areas are in woodland.

Representative profile of Kolberg silt loam, 1 to 6 percent slopes, in an uncultivated area 1,980 feet west and 600 feet south of the northeastern corner of sec. 36, T. 24 N., R. 18 E.

A1—0 to 5 inches; very dark brown (10YR 2/2) silt loam; moderate fine granular structure; very friable; few roots; mildly alkaline; clear smooth boundary.

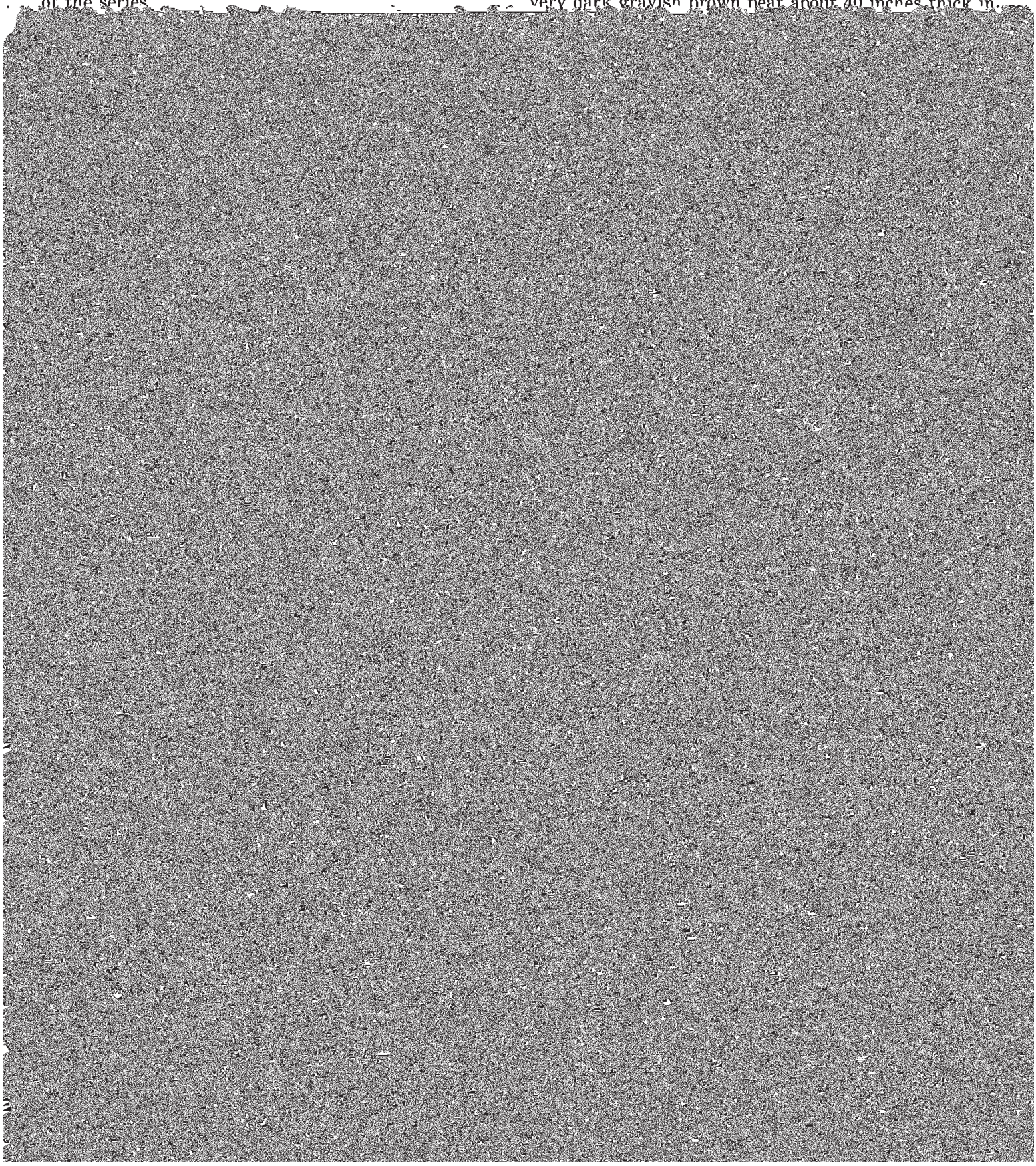
B&A—5 to 9 inches; brown (10YR 4/3) silt loam (A2) interfingers around reddish brown (5YR 4/4) silty clay loam (B2t); moderate medium subangular blocky structure; friable; few roots; few medium faint very dark grayish brown (10YR 3/2) worm casts; neutral; clear wavy boundary.

B21t—9 to 14 inches; reddish brown (5YR 4/4) clay; strong coarse subangular blocky structure; firm; medium continuous clay films on all faces of peds; neutral; gradual smooth boundary.

B22t—14 to 22 inches; reddish brown (5YR 4/4)

size. This soil has the profile described as representative of the series.

inches or more thick. It is light yellowish brown and very dark grayish brown neat about 40 inches thick in.



few small areas where the organic soil contains less fibrous material are also included.

This soil has low natural fertility and very high organic-matter content. The effective rooting zone is limited by a high water table. Runoff is very slow but not ponded. The extreme acidity and high fiber content limit the use of this soil. There is a hazard of frost damage to crops that are grown on this soil.

All areas of this soil are undrained and used primarily for wildlife areas. This soil is a good source of sphagnum moss for nurseries and greenhouses. Capability unit VIIw–10; woodland group 4w.

## Manawa Series

The Manawa series consists of nearly level and gently sloping, somewhat poorly drained soils in depressions and drainageways on glacial till plains and in lacustrine basins. These soils formed under natural vegetation of mixed hardwoods and conifers, mainly maple, oak, and white pine.

In a representative profile the surface layer is very

firm; slight effervescence; mildly alkaline; clear wavy boundary.

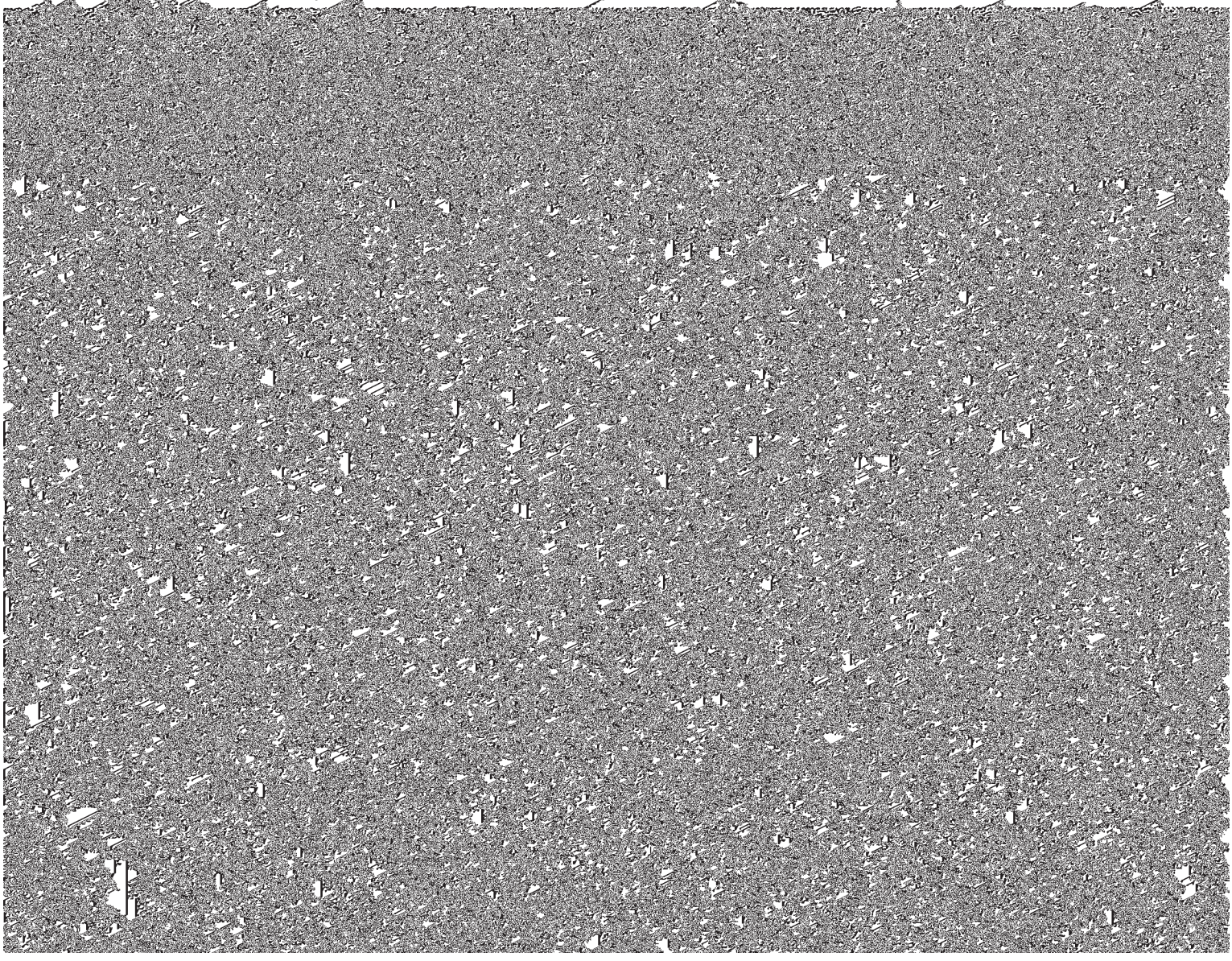
C—30 to 60 inches; yellowish red (5YR 4/6) silty clay; massive; very firm; violent effervescence; moderately alkaline.

The solum is 24 to 36 inches thick. The A horizon is neutral or mildly alkaline, the B horizon is slightly acid to moderately alkaline, and the C horizon is moderately alkaline.

The A horizon is very dark grayish brown, very dark brown, or black and is 7 to 10 inches thick. The Bt and C horizons are heavy silty clay loam, silty clay, or clay.

Manawa soils are near Allendale, Bonduel, Kewaunee, Poygan, and Winneconne soils. They lack the sandy overburden of Allendale soils and the limestone bedrock which underlies Bonduel soils. Manawa soils are better drained than Poygan soils and are wetter than Kewaunee and Winneconne soils.

**McA—Manawa silty clay loam, 1 to 3 percent slopes.** This nearly level and gently sloping soil is in drainageways and depressions on till plains and in glacial lake

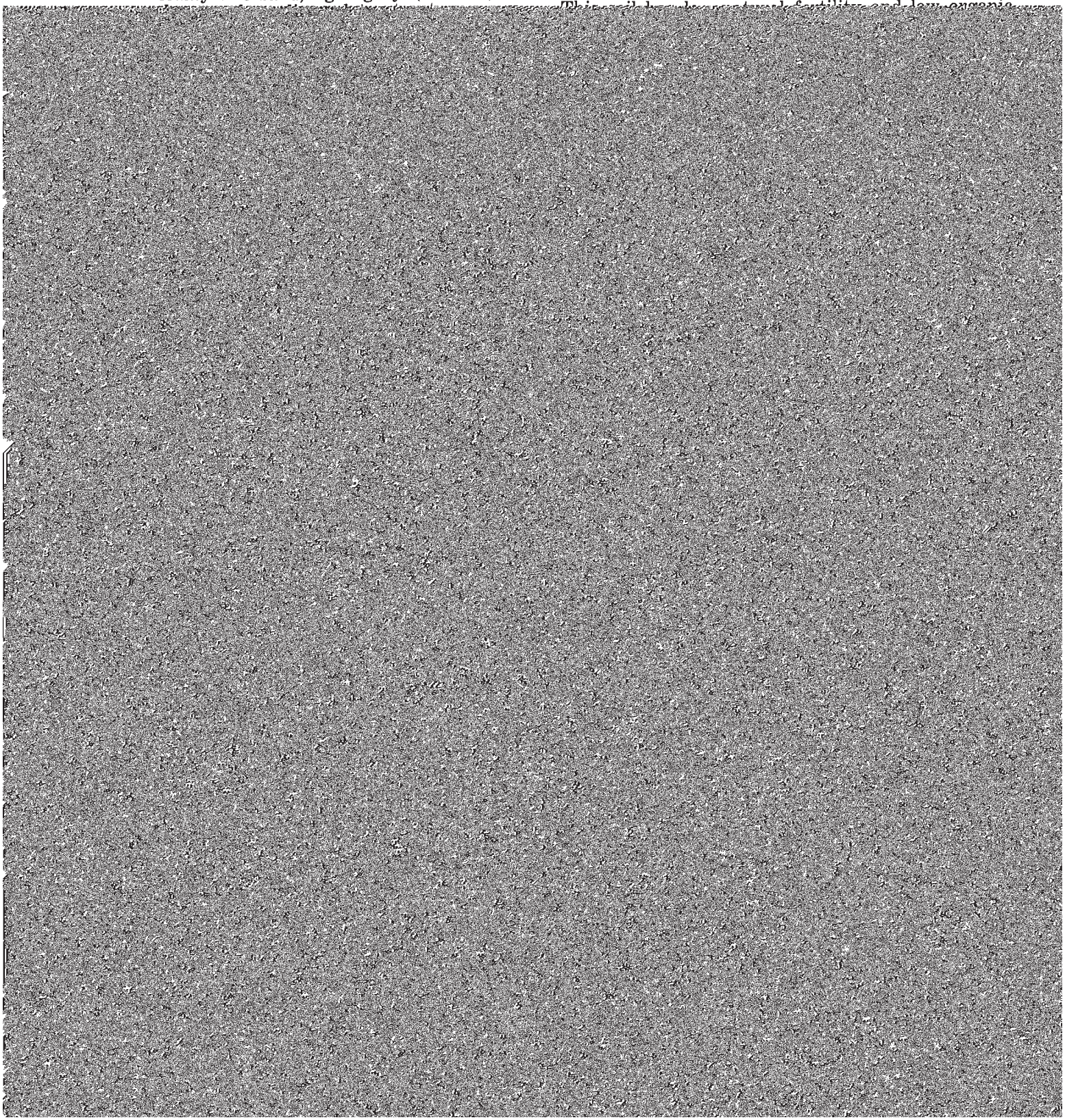


3/2) fine sandy loam, light brownish gray (10YR 6/2) dry; moderate fine granular structure; very friable; few roots; slightly acid; abrupt smooth boundary.

A2—9 to 14 inches; grayish brown (10YR 5/2) loamy fine sand, light gray (10YR 7/2)

face layer of this soil is thinner and has more sand than the one described as representative of the series.

Included with this soil in mapping are a few small areas of Kewaunee soils and some areas of gently sloping Manistee loamy fine sand. Also included are a few small areas of Manistee fine sandy loam.



friable; medium acid; abrupt smooth boundary.

IIC—25 to 60 inches; grayish brown (2.5Y 5/2) sand; common medium prominent brownish yellow (10YR 6/6) mottles; single grained; loose; neutral.

The organic layer is commonly 20 to 30 inches thick, but ranges to 51 inches thick. It is medium acid to mildly alkaline. The IIC horizon is slightly acid to moderately alkaline.

The organic layer is very dark brown or black muck. The fiber content is less than 10 percent in all organic layers after rubbing. The IIC horizon is typically fine or medium sand and is less commonly loamy sand.

Markey soils are near Carbondale, Cathro, Rondeau, and Suamico soils. They have shallower organic deposits than Carbondale soils. Markey soils are underlain by sand, Cathro soils are underlain by loamy material, Suamico soils are underlain by clay, and Rondeau soils are underlain by marl.

**Mk—Markey muck.** This is a nearly level soil in depressions on outwash plains and stream bottoms. Most areas are irregular in shape and range from 10 to 300 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are a few small areas of Carbondale and Deford soils. Also included are some small areas of Markey soils that have slopes up to 4 percent.

The soil has low natural fertility and very high organic-matter content. The effective rooting depth is limited by the water table and, in drained areas, by depth to sand. Runoff is slow or ponded. Wetness is the major limitation to use of this soil. Where drained and

weak very fine granular structure; very friable; common roots; pinkish gray (5YR 7/2) clear quartz grains cover about 30 percent of surface; strongly acid; abrupt wavy boundary.

A2—4 to 6 inches; brown (7.5YR 5/2) fine sand; weak very thin platy structure; common roots; loose; medium acid; abrupt irregular boundary.

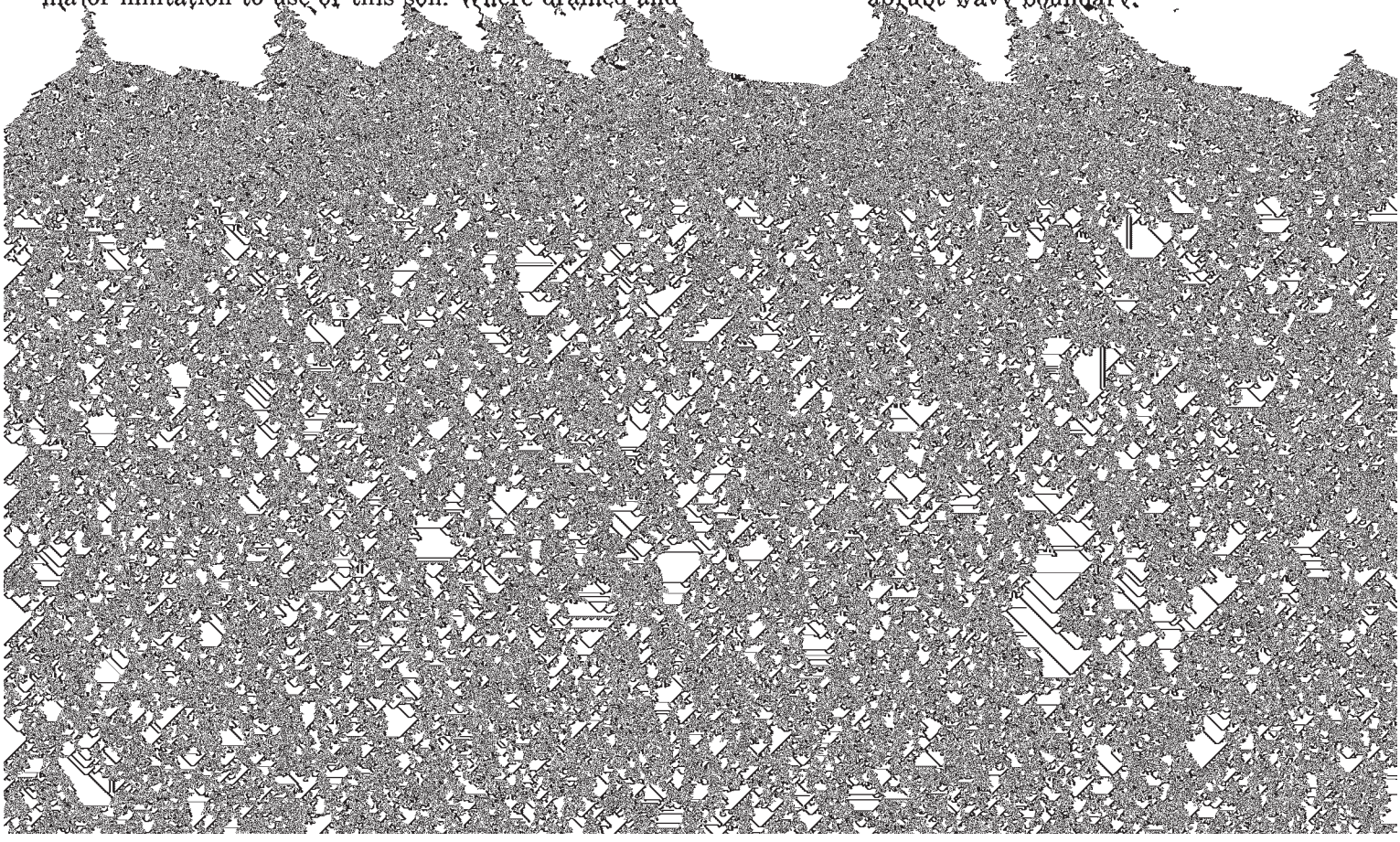
B21ir—6 to 11 inches; dark brown (7.5YR 4/4) fine sand; weak medium subangular blocky structure; weakly cemented; common roots; medium acid; clear wavy boundary.

B22ir—11 to 16 inches; dark brown (7.5YR 4/4) fine sand; strong coarse subangular blocky structure; weakly cemented; common roots; medium acid; clear wavy boundary.

B23ir—16 to 21 inches; yellowish brown (10YR 5/4) fine sand; weak fine subangular blocky structure; loose; slightly acid; abrupt wavy boundary.

A′2—21 to 27 inches; light brown (7.5YR 6/4) fine sand; weak thin platy structure; loose; medium acid; clear wavy boundary.

IIB&A—27 to 36 inches; reddish brown (5YR 4/4) light clay loam, light brown (7.5YR 6/4) fine sand coatings on faces of peds (A′2); moderate medium subangular blocky structure; friable; medium acid; abrupt wavy boundary.



matter content. The effective rooting zone is deep. Runoff is slow. Drought is a moderate hazard, and water erosion is a slight hazard. Applying organic

brownish gray (10YR 6/2) and few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular

400 feet east of the northwestern corner of sec. 23, T. 22 N., R. 16 E.

Ap—0 to 10 inches; black (10YR 2/1) silt loam; moderate medium granular structure; friable; many roots; neutral; abrupt smooth boundary.

B2t—10 to 22 inches; brown (7.5YR 5/4) silty clay loam; many fine distinct strong brown (7.5YR 5/8) and grayish brown (10YR 5/2) mottles; moderate fine subangular blocky structure; friable; many roots to 15 inches; thin patchy clay films; neutral; clear smooth boundary.

B3t—22 to 27 inches; brown (7.5YR 5/4) light silty clay loam; many fine distinct strong

Namur soils have very low available water capacity and moderate permeability.

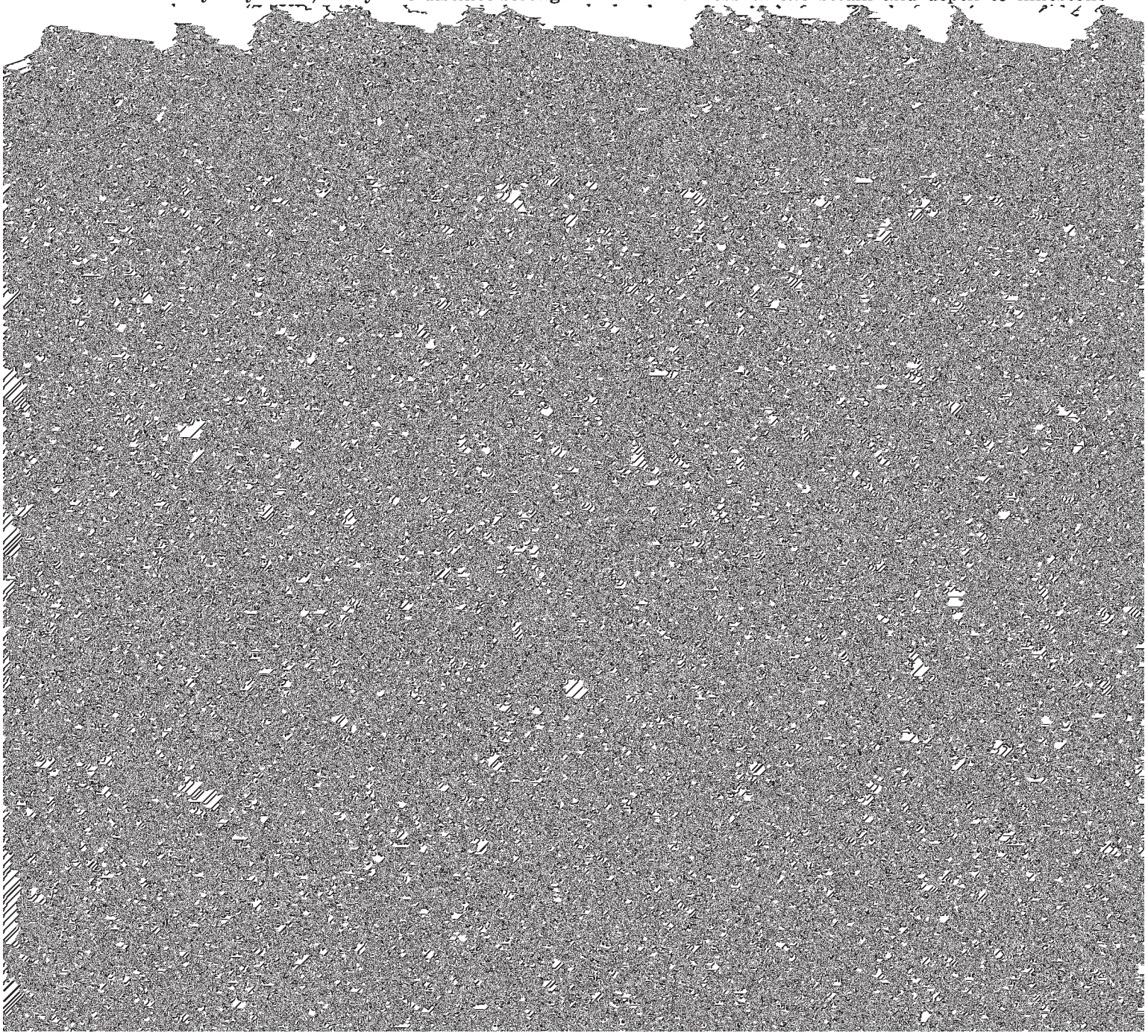
Most areas of these soils are in woodland or wildlife habitat and some are used for pasture.

Representative profile of Namur silt loam, 1 to 6 percent slopes, in a woodlot 1,380 feet south and 325 feet west of the northeastern corner of sec. 30, T. 22 N., R. 15 E.

A1—0 to 5 inches; very dark brown (10YR 2/2) silt loam; moderate fine and medium subangular blocky structure; very friable; neutral; abrupt smooth boundary.

R—5 to 60 inches; light gray (10YR 7/2) consolidated limestone bedrock.

The thickness of the solum and depth to limestone



fine granular structure; very friable; slightly acid; abrupt smooth boundary.

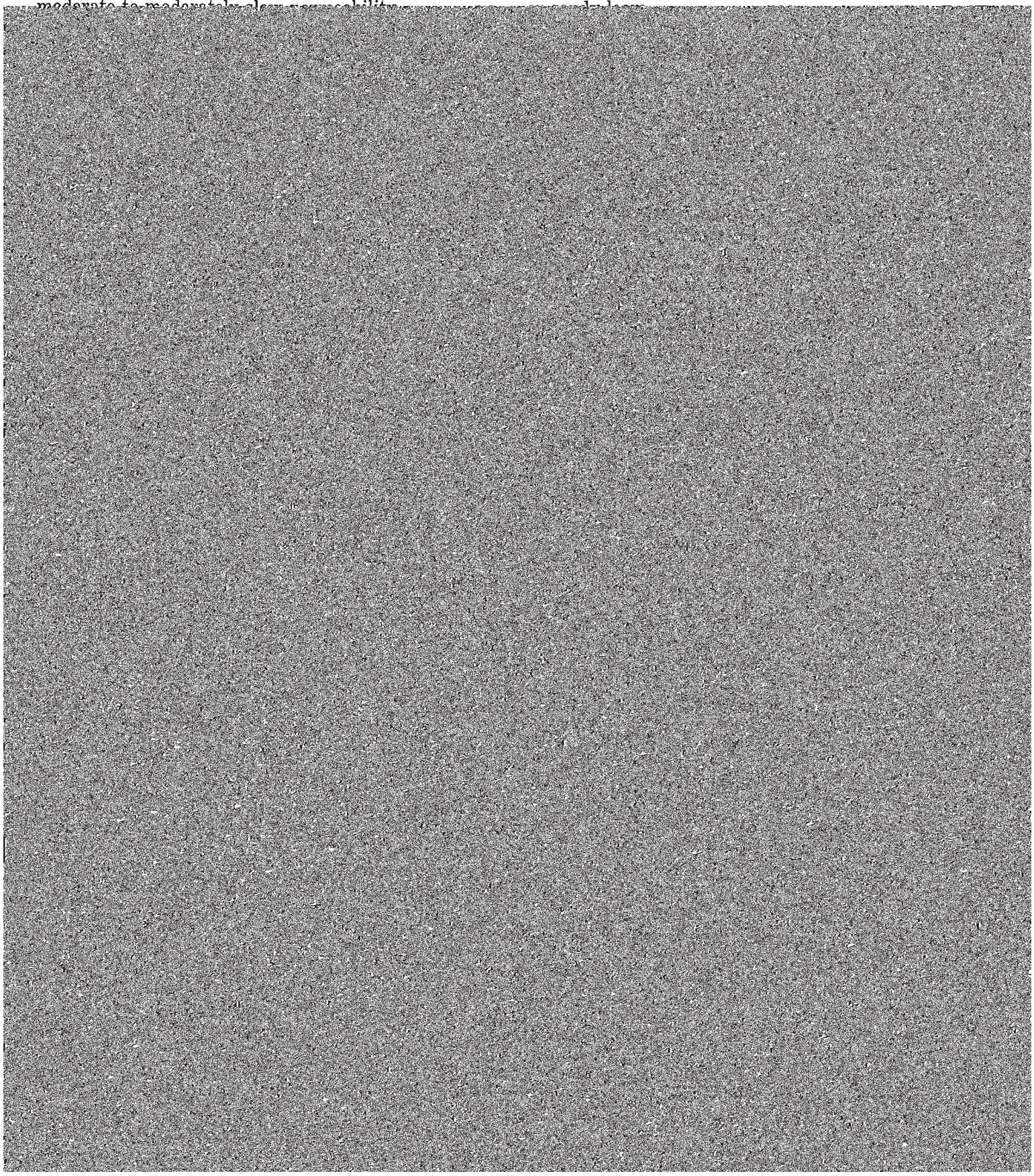
B1—8 to 11 inches; brown (10YR 5/3) very fine sandy loam; moderate fine subangular blocky structure; very friable; neutral; abrupt wavy boundary.

B2—11 to 17 inches; dark brown (7.5YR 4/4) very fine sandy loam; weak medium platy structure parting to moderate fine sub-

Most areas of this soil are used for cultivated crops. Some areas remain in woodland or pasture. This soil is well suited to all crops commonly grown in the county and to specialty crops, such as cabbage and cauliflower. Capability unit IIe–1; woodland group 1o.

**NsA—Nichols very fine sandy loam, clayey substratum, 0 to 2 percent slopes.** This nearly level soil is in glacial lake basins. Most areas are irregular in shape and range from 5 to 200 acres in size. This soil has a

Onaway soils have high available water capacity and moderate to moderately slow permeability. loam in the lower part. The C horizon is silt loam, loam,



about 200 acres in size. This complex is about 60 percent Onaway loam and 35 percent Solona silt loam. Onaway soils are on convex side slopes on uplands. Solona soils are in drainageways and depressions. The soils in this complex are in such small areas and are so closely intermingled that it is not feasible to map them individually at the scale used.

Included in mapping are small areas of Angelica soils in wet depressions.

Runoff is very slow or slow. Erosion is the main hazard on Onaway soils, and wetness is the main hazard on Solona soils. Surface drainage and tile drainage help remove excess water. Stripcropping, contour cultivation, and minimum tillage reduce runoff and erosion.

Most of this complex is cultivated. If properly managed, the soils are well suited to all crops commonly grown in the county. Uncultivated areas are mostly [illegible] soils. They are used for pasture or woodland.

yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; firm; distinct very dark brown (10YR 2/2) worm casts; neutral; abrupt wavy boundary.

IIB3g—26 to 29 inches; dark gray (10YR 4/1) stratified silty clay loam and loam; many coarse distinct dark grayish brown (10YR 4/2) and yellowish brown (10YR 5/6) mottles; moderate coarse prismatic structure; firm; neutral; abrupt wavy boundary.

IIC—29 to 60 inches; mixed dark yellowish brown (10YR 4/4), yellow (10YR 7/6), and gray (10YR 5/1) light clay loam stratified with layers of sandy loam and silt loam; massive; friable; slight effervescence; mildly alkaline.

The solum ranges from 20 to 40 inches in thickness [illegible]

ability is slow in the subsoil and rapid in the substratum.

Most areas of these soils are drained and used for all crops commonly grown in the county. Undrained areas are in woodland.

Representative profile of Poy silty clay loam, in cropland 2,510 feet north and 1,320 feet east of the southwestern corner of sec. 31, T. 21 N., R. 16 E.

Ap—0 to 8 inches; very dark brown (10YR 2/2) silty clay loam; moderate fine granular structure; friable; many roots; neutral; abrupt smooth boundary.

B1g—8 to 10 inches; dark gray (N 4/0) silty clay; few medium prominent reddish brown (5YR 5/4) and olive (5Y 4/3) mottles; moderate fine subangular blocky structure; firm; many roots; few coarse prominent very dark brown (10YR 2/2) worm casts; neutral; clear wavy boundary.

B2g—10 to 14 inches; dark grayish brown (2.5Y 4/2) clay; common fine prominent brown (7.5YR 5/4) mottles; moderate fine subangular blocky structure; firm; few roots; neutral; clear wavy boundary.

B3—14 to 24 inches; reddish brown (5YR 4/3) adequate drainage is provided. Capability unit IIw–5; woodland group 2w.

## Poygan Series

The Poygan series consists of poorly drained, nearly level soils in depressions and drainageways on lacustrine and glacial till plains. These soils formed under a mixed vegetation of elm, maple, and ash.

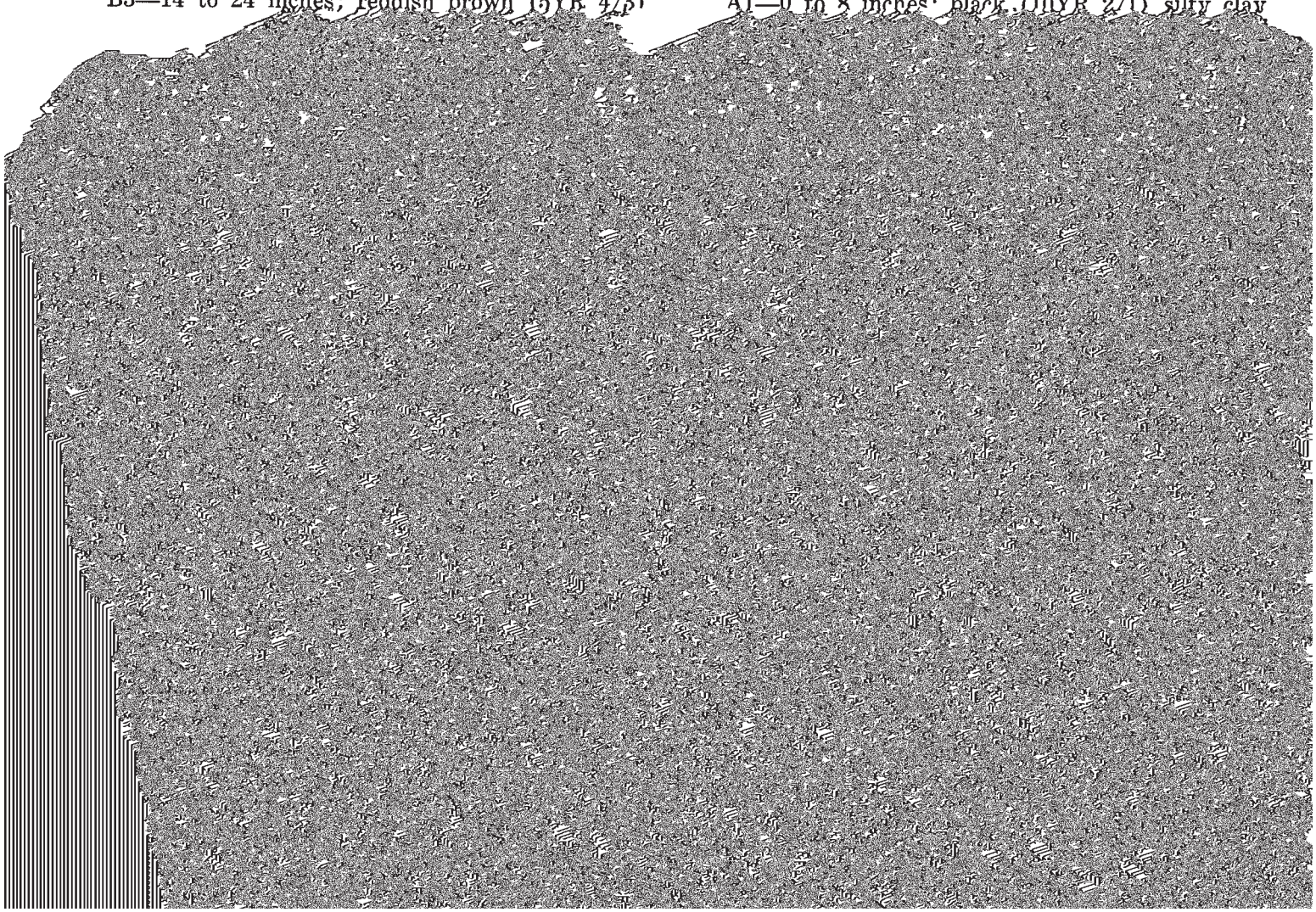
In a representative profile the surface layer is black silty clay loam about 8 inches thick. The subsoil is about 16 inches thick. It is very dark gray and dark gray mottled silty clay in the upper part; brown mottled clay in the middle part; and dark reddish gray mottled clay in the lower part. The substratum is reddish brown mottled clay to a depth of about 60 inches.

Poygan soils have moderate available water capacity and slow permeability.

Most areas of these soils are undrained and in woodland. Some areas are drained and used for all crops commonly grown in the county.

Representative profile of Poygan silty clay loam, in an uncultivated area 600 feet south and 250 feet east of the northwestern corner of sec. 31, T. 21 N., R. 19 E.

A1—0 to 8 inches; black (10YR 2/1) silty clay



Poygan soils are near and are wetter than Kewaunee, Manawa, and Winneconne soils.

**Po—Poygan silty clay loam.** This is a nearly level soil in drainageways and depressions on lacustrine and glacial till plains. Most areas are irregular in shape and range from 2 to 600 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are some areas of Manawa and Suamico soils.

This soil has high natural fertility and organic-matter content. The effective rooting depth is limited by the water table. Runoff is very slow or ponded. The major management concerns are wetness and maintenance of good tilth. Tile drainage and surface drainage are beneficial in removing excess water. Minimum tillage (especially not cultivating when the soil is wet) and additions of organic matter help maintain good tilth.

Most large areas of this soil remain in woodland and are used for wildlife habitat. This soil is well suited to woodland. If drained, it is well suited to most crops commonly grown in the county. Capability unit IIw–1; woodland group 2w.

## Rock Outcrop

**Ra—Rock outcrop.** This is a miscellaneous area consisting of steep and very steep escarpments of limestone bedrock and, in a few places, exposed sandstone bedrock. Most areas are long and narrow and range from 3 to 35 acres in size.

Included in mapping are small areas of Bonduel, Kolberg, and Namur soils. Also included are stones and boulders at the foot of the escarpments. Soil material fills crevices in the dolomite (limestone) in many areas.

Runoff is very rapid. Erosion is a slight hazard. Rock outcrop is not rated for soil properties or for any selected use.

Rock outcrop is unsuited to farming, but some areas are wooded. Trees grow in soil-filled crevices in the bedrock. The bedrock is used as a source of lime, sand, and building stone. Areas of Rock outcrop are valuable for their scenic beauty and as wildlife habitat. Capability

15 percent fiber, less than 5 percent rubbed; moderate medium granular structure; nonsticky herbaceous fibers; many roots; mildly alkaline; abrupt smooth boundary.

Oe1—15 to 20 inches; very dark brown (10YR 2/2) broken face and very dark grayish brown (10YR 3/2) rubbed hemic material; 65 percent fiber, less than 40 percent rubbed; massive; nonsticky herbaceous fibers; mildly alkaline; abrupt smooth boundary.

Oa2—20 to 22 inches; black (10YR 2/1) broken face and rubbed sapric material; about 50 percent fiber, less than 10 percent rubbed; massive; nonsticky herbaceous fibers; 2 percent white (10YR 8/1) snail shells; mildly alkaline; abrupt smooth boundary.

Lca—22 to 60 inches; mixed dark gray (5Y 4/1) and gray (5Y 5/1) marl; massive; slightly sticky; about 2 percent detritus; 25 percent white (10YR 8/1) snail shells; violent effervescence; mildly alkaline.

The organic layers are 16 to 51 inches thick. They are mostly sapric material, but hemic layers less than 10 inches thick are in some pedons.

Rondeau soils are near Carbondale, Cathro, Markey, and Suamico soils and formed in similar organic deposits. Rondeau soils are underlain by marl within a depth of 51 inches. Cathro soils are underlain by loamy material, Markey soils are underlain by sand, and Suamico soils are underlain by clayey material. Carbondale soils formed in organic deposits that are more than 51 inches thick.

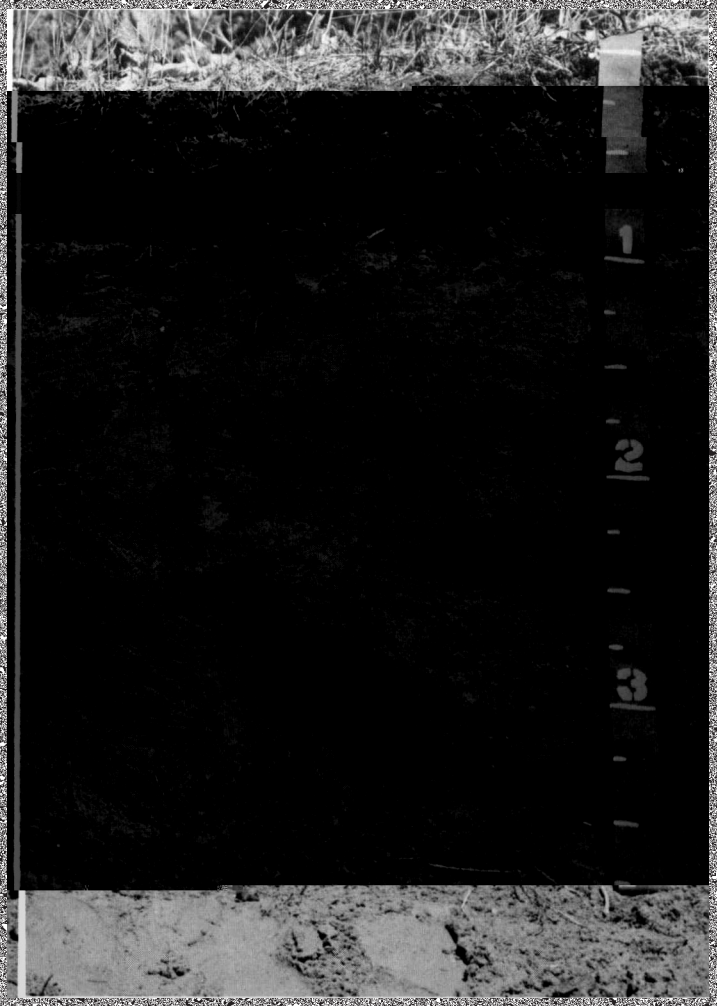
**Rd—Rondeau muck.** This is a nearly level soil in glacial lake basins. Most areas are irregular in shape and range from 2 to 240 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are a few small areas of Carbondale, Cathro, and Markey soils.

This soil has low natural fertility and very high organic-matter content. The effective rooting depth is

the lower part. The substratum is brown fine sand to a depth of about 60 inches.

rolling and hilly soils on sand dunes and outwash ridges. The native vegetation consisted of red oak,



weak fine subangular blocky structure; very friable; slightly acid; clear smooth boundary.

C—28 to 60 inches; yellowish brown (10YR 5/6) fine sand; single grained; loose; slightly acid.

The solum is 20 to 40 inches thick and is medium acid or slightly acid. The C horizon is medium acid to mildly alkaline. The A horizon is very dark grayish brown or black and is typically less than 6 inches thick. The B horizon is fine sand or very fine sand.

Shawano soils are near Boyer and Rousseau soils. They have more sand in the B horizon and finer sand in the C horizon than Boyer soils. Shawano soils have less iron accumulation in the solum than Rousseau soils.

**SeC—Shawano fine sand, rolling.** This soil is on sand dunes in areas of glacial outwash. Most areas are

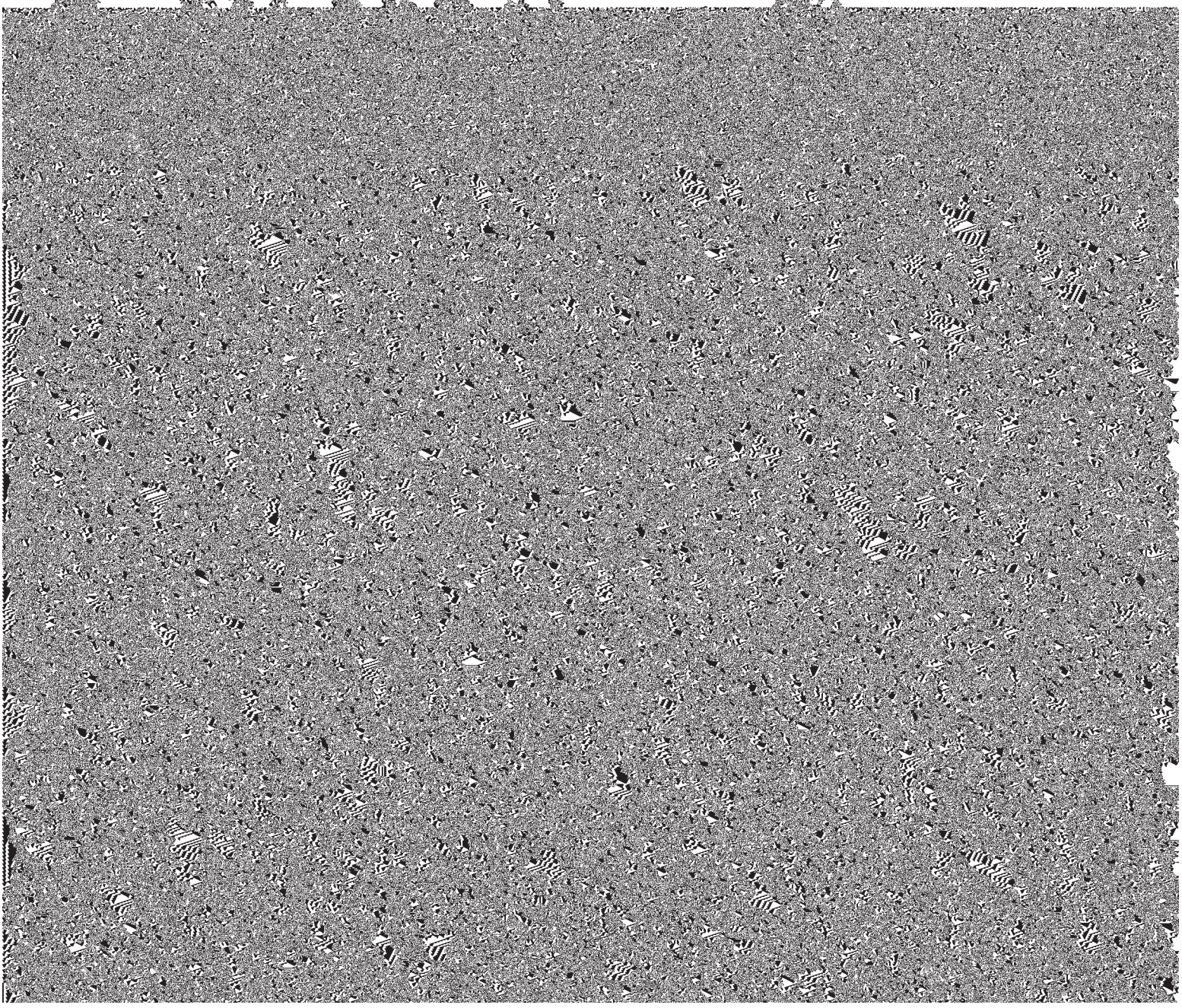
60 inches is brown mottled silt stratified with very fine sand.

Shiocton soils have high available water capacity. Permeability is moderate, except it is very slow in the substratum of the Shiocton clayey substratum soils.

These soils are used for crops and pasture. Undrained areas are mostly in woodland or wildlife habitat.

Representative profile of Shiocton silt loam, 0 to 3 percent slopes, in cropland 2,030 feet south and 50 feet west of the northeastern corner of sec. 21, T. 22 N., R. 17 E.

Ap—0 to 10 inches; very dark grayish brown (10YR 3/2) silt loam; weak medium and fine subangular blocky structure; very friable; common roots; slight effervescence; mildly alkaline; abrupt smooth boundary.



**ShA—Shiocton silt loam, 0 to 3 percent slopes.** This nearly level and gently sloping soil is on lacustrine plains. Most areas are irregular in shape and range from 2 to 1,200 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of Shiocton soil where the surface layer is very fine sandy loam and a few areas of Mundelein and Nichols soils.

This soil has high natural fertility and high organic-matter content. The effective rooting depth is limited by the water table. Runoff is very slow. Wetness is the main limitation of this soil. This soil is subject to flooding for brief periods. Surface drainage removes excess water.

This soil is used for crops or pasture. Many areas remain in woodland and are used for wildlife habitat. If drained, this soil is well suited to most crops commonly grown in the county and to specialty crops, such as cabbage and cauliflower. It is also well suited to growing row crops year after year. Capability unit IIw–4; woodland group 1o.

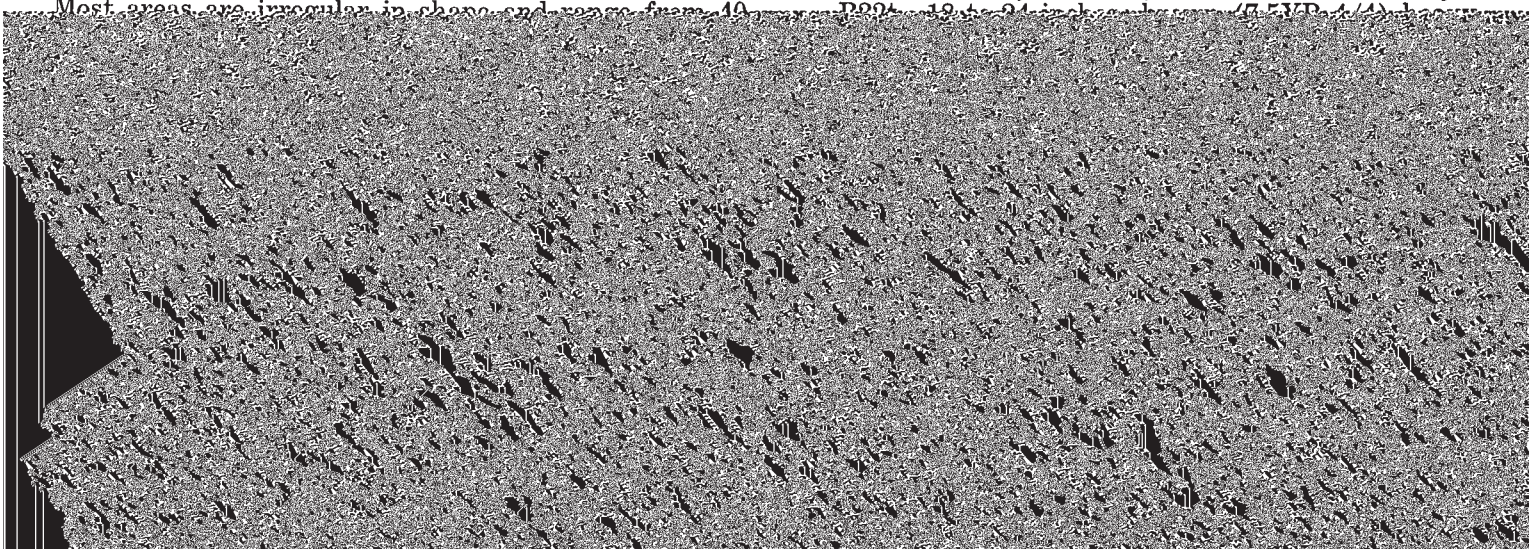
**SkA—Shiocton silt loam, clayey substratum, 0 to 3 percent slopes.** This nearly level and gently sloping soil is on lacustrine plains. Most areas are elongated and range from 5 to 200 acres in size. This soil is similar to the one described as representative of the series, but it is underlain by clayey material at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of Keowns and Mundelein soils. Also included are areas where the clayey substratum is at a depth of 30 to 40 inches and some areas that lack a clayey substratum.

This soil has high natural fertility and high organic-matter content. The effective root zone is limited by the water table and, in drained areas, by the underlying clayey substratum. This soil is subject to frequent flooding. Surface drainage can be used to remove excess water.

Where drained, most areas of this soil are used for crops and pasture. This soil is well suited to continuous row cropping and woodland. Undrained areas are used for permanent pasture, woodland, or wildlife habitat. Capability unit IIw–4; woodland group 1o.

**SnB—Shiocton-Nichols complex, 2 to 6 percent slopes.** These undulating soils are on lacustrine plains. Most areas are irregular in shape and range from 10 [illegible]



well suited to all crops commonly grown in the county and to specialty crops, such as cabbage and cauliflower. Capability unit IIe–1; woodland group 1o.

## Solona Series

The Solona series consists of somewhat poorly drained, nearly level and gently sloping soils on glacial till plains. The natural vegetation was dominantly mixed deciduous forest consisting of elm, ash, maple, some white-cedar, and red oak.

In a representative profile the surface layer is black silt loam about 8 inches thick. The subsurface layer is dark grayish brown mottled silt loam about 3 inches thick. The subsoil is brown mottled heavy loam 13 inches thick. The substratum is reddish brown mottled loam to a depth of about 60 inches.

Solona soils have high available water capacity and moderate permeability.

Most areas of these soils are drained and used for all crops commonly grown in the county. Undrained areas are in woodland.

Representative profile of Solona silt loam, 1 to 3 percent slopes, in an uncultivated area 200 feet north and 1,980 feet west of the southeastern corner of sec. 6, T. 24 N., R. 19 E.

A1—0 to 8 inches; black (10YR 2/1) silt loam; moderate fine granular structure; very friable; many roots; neutral; abrupt wavy boundary.

A2—8 to 11 inches; dark grayish brown (10YR 4/2) silt loam; few fine prominent strong brown (7.5YR 5/6) mottles; weak medium platy structure parting to moderate fine subangular blocky; very friable; many roots; common coarse distinct black (10YR 2/1) worm casts; neutral; abrupt wavy boundary.

B21t—11 to 18 inches; brown (7.5YR 4/4) heavy loam; few fine distinct strong brown (7.5YR 5/6) and light brownish gray (10YR 6/2) mottles; thin patchy clay films on faces of peds; moderate medium subangular blocky structure; friable; mildly alkaline; clear smooth boundary.

B22t—18 to 24 inches; [illegible] (7.5YR 4/4) heavy

sandy loam, or clay loam. The C horizon is loam or sandy loam.

Solona soils are near Angelica, Menominee, and Onaway soils. They are better drained than Angelica soils. Solona soils are lower on the landscape and are wetter than Onaway and Menominee soils. They lack the sandy overburden that Menominee soils have.

Suamico soils are near Carbondale, Cathro, Markey, and Rondeau soils. They are now classified within the range of the Cathro series. They have shallower organic layers than Carbondale soils have. Suamico soils are underlain by clayey material, Cathro soils are underlain by loamy material, Markey soils are underlain by sandy material, and Rondeau soils are underlain by

brown (10YR 4/2) and yellowish red (5YR 4/6) mottles; moderate fine and medium subangular blocky structure; friable; few roots; thin patchy clay films; few coarse prominent black (10YR 2/1) worm casts; mildly alkaline; abrupt wavy boundary.

B22t—14 to 22 inches; reddish brown (5YR 4/4) heavy clay loam; few fine distinct dark grayish brown (10YR 4/2) and yellowish red (5YR 4/6) mottles; moderate fine subangular blocky structure; friable; medium continuous clay films; mildly alkaline; clear wavy boundary.

B3t—22 to 25 inches; reddish brown (5YR 4/4) clay loam; few fine distinct dark grayish brown (10YR 4/2) and yellowish red (5YR 4/6) mottles; weak coarse subangular blocky structure; firm; thin patchy clay films; many coarse prominent yellow (10YR 8/6) calcium carbonate segregations; slight effervescence; moderately alkaline; clear wavy boundary.

C—25 to 60 inches; reddish brown (5YR 4/4) heavy loam; few fine distinct dark grayish brown (10YR 4/2) and yellowish red (5YR 4/6) mottles; massive; firm; many coarse prominent yellow (10YR 8/6) calcium carbonate segregations; violent effervescence; moderately alkaline.

The solum ranges from 20 to 40 inches in thickness, but generally is 22 to 28 inches thick. The depth to free carbonates is generally the same. The A horizon is neutral or mildly alkaline, and the B and C horizons are mildly alkaline to moderately alkaline.

The A horizon is very dark brown or black and is 6 to 20 inches thick. The B horizon is clay loam or silty clay loam and less commonly is heavy silt loam. The C horizon is heavy loam, clay loam, or silty clay loam.

Symco soils are near Bonduel, Hortonville, and Pella soils. They lack the limestone bedrock substratum that is characteristic of Bonduel soils. Symco soils are wetter than Hortonville soils and not so wet as Pella soils.

**SyA—Symco silt loam, 1 to 3 percent slopes.** This nearly level and gently sloping soil is in depressions and drainageways on glacial till plains. In drainageways, most areas are long and narrow, and in depressions they are irregular in shape. Areas range from 2 to 160 acres in size.

Included with this soil in mapping are small areas of Hortonville and Pella soils.

This soil has high natural fertility and moderate organic-matter content. The effective rooting depth is limited by the water table. Runoff is very slow. Wetness is the main limitation to use of this soil. It needs to be drained for best crop growth.

Most areas of this soil are used for crops. This soil is well suited to crops commonly grown in the county if it is drained. It is also well suited to woodland production. Capability unit IIw–2; woodland group 1o.

## Symco Variant

The Symco variant consists of somewhat poorly drained, nearly level and gently sloping soils on outwash plains. The natural vegetation was northern red oak, white oak, hickory, ash, and basswood.

In a representative profile the surface layer is very dark brown silt loam about 8 inches thick. The subsurface layer is brown mottled silt loam about 4 inches thick. The subsoil is about 14 inches thick. It is dark yellowish brown mottled silty clay loam in the upper part and brownish yellow mottled sandy loam in the lower part. The substratum is yellowish brown mottled sand and gravel to a depth of about 60 inches.

Symco variant soils have moderate available water capacity. Permeability is moderate in the solum and rapid in the substratum.

Representative profile of Symco variant, 0 to 3 percent slopes, in a cultivated field now idle, 400 feet west and 1,380 feet north of the southeastern corner of sec. 36, T. 21 N., R. 16 E.

Ap—0 to 8 inches; very dark brown (10YR 2/2) silt loam; moderate fine granular structure; very friable; many roots; neutral; clear smooth boundary.

A2—8 to 12 inches; brown (10YR 5/3) silt loam; many coarse faint grayish brown (10YR 5/2) and common fine prominent yellowish brown (10YR 5/6) mottles; thin platy structure parting to very fine subangular blocky; friable; many medium distinct very dark grayish brown (10YR 3/2) worm casts; neutral; clear wavy boundary.

B2t—12 to 22 inches; dark yellowish brown (10YR 4/4) silty clay loam; common fine distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; thin patchy clay films; neutral; clear wavy boundary.

IIB3t—22 to 26 inches; brownish yellow (10YR 6/6) sandy loam; few medium prominent light gray (10YR 7/1) and few medium distinct yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; very friable; clay bridging between sand grains; violent effervescence; mildly alkaline; clear wavy boundary.

IIC—26 to 60 inches; yellowish brown (10YR 5/4) sand and gravel; few medium distinct reddish yellow (7.5YR 6/6) mottles; single grained; loose; violent effervescence; moderately alkaline.

The solum thickness and the depth to sand and gravel are 24 to 40 inches. The A1 or Ap horizon is very dark brown or very dark grayish brown and is 6 to 10 inches thick. The B horizon is sandy loam, silty clay loam, or clay loam. The C horizon is sand and gravel.

Symco variant soils are near Casco and Will soils. They have a thicker solum and are wetter than Casco soils and are better drained than Will soils.

**SzA—Symco variant, 0 to 3 percent slopes.** This nearly level and gently sloping soil is in depressions along streams on outwash plains. Most areas are long and narrow and range from 2 to 40 acres in size.

Included with this soil in mapping are some areas of poorly drained soils.

This soil has high natural fertility and moderate

organic-matter content. The effective rooting depth is limited by the water table and the underlying gravelly substratum. Runoff is very slow. Wetness is the major limitation to use of this soil. It can be drained by open ditches or by tile lines.

Most drained areas of this soil are used for crops or pasture. Undrained areas remain in woodland or wildlife habitat. This soil is well suited to most crops

Wainola soils have low available water capacity and rapid permeability.

Most areas of these soils are in woodland or undrained pasture.

Representative profile of Wainola loamy fine sand, 0 to 3 percent slopes, in an uncultivated area 1,320 feet south and 660 feet east of the northwestern corner of sec. 6, T. 24 N., R. 17 E.

commonly grown in the county. It is suited to wood crop production. Capability unit IVw–5; woodland group 3w.

## Will Series

surface layer and subsoil and some areas of soils that have a thin organic surface layer.

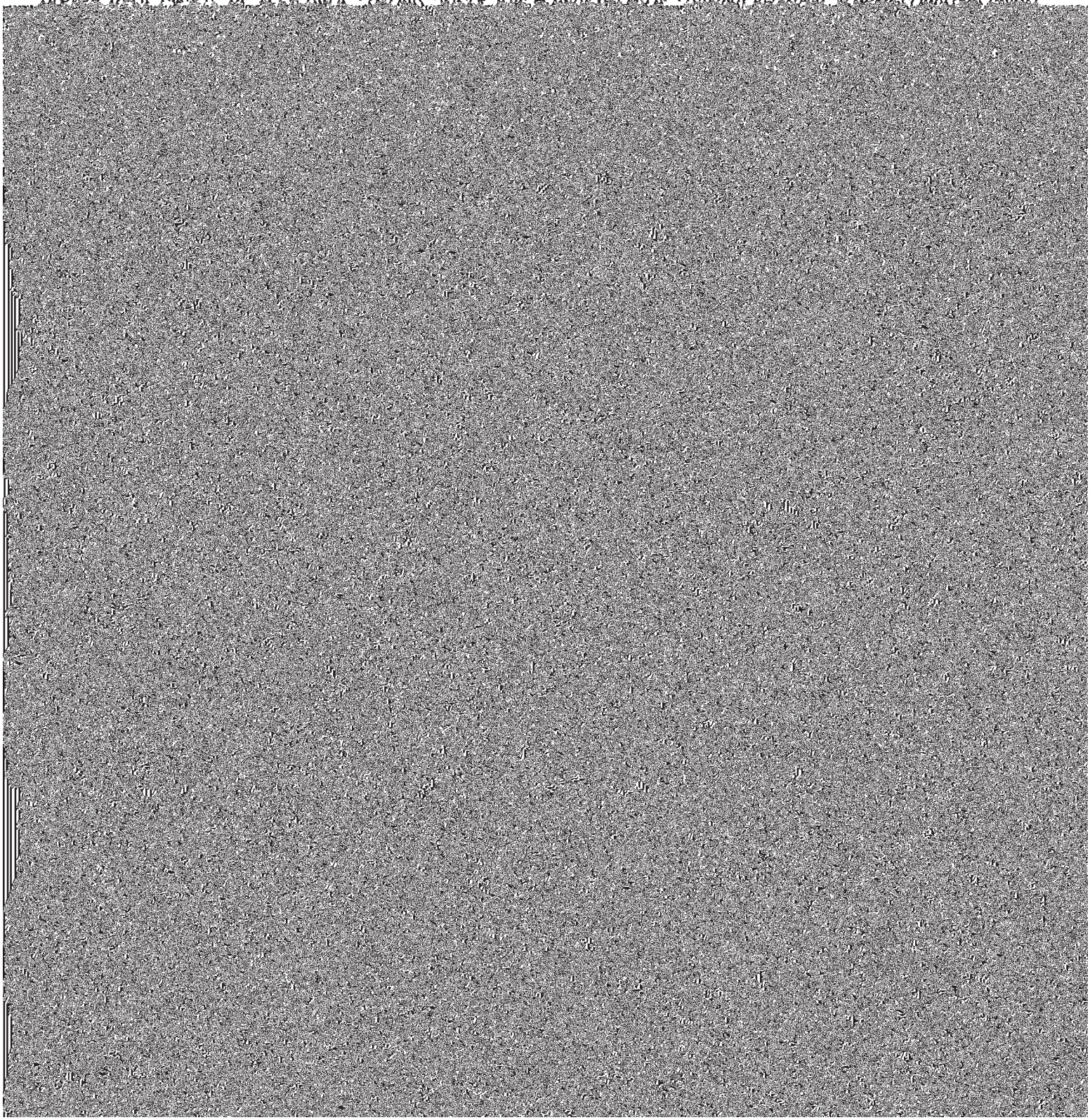
This soil has high natural fertility and organic-matter content. The effective rooting depth is limited by the water table and, in drained areas, by the sand and gravel substratum. Runoff is very slow or ponded. This

soft lime segregations; violent effervescence; mildly alkaline.

The solum thickness and the depth to free carbonates typically are 25 to 35 inches. The solum is slightly acid to mildly alkaline. The C horizon is mildly alkaline or moderately alkaline. The A horizon is very dark brown, dark brown, or very dark grayish brown and

deep. Runoff is rapid. Erosion is the main hazard. Good tilth is difficult to maintain on this soil. Contour stripcropping and waterways help control runoff and erosion. Minimum tillage, applying manure, and plowing under crop residue help maintain good soil tilth.

Most areas of this soil are used for crops or permanent pasture. This soil is suited to most crops commonly



soft calcium carbonate segregations; moderately alkaline.

The solum ranges from 24 to 40 inches thick but is commonly 25 to 36 inches thick. The A and B horizons are medium acid to neutral, and the IIC horizon is neutral to moderately alkaline.

The A horizon is very dark brown, very dark grayish brown, or black and is 6 to 20 inches thick. The B horizon is silty clay or clay. The C horizon is typically stratified sand and some gravel, but includes sand or loamy sand in some pedons.

Zittau soils are near Borth and Poy soils. They form a drainage sequence with the well drained Borth soils and the poorly drained Poy soils.

**ZtA—Zittau silty clay loam, 0 to 3 percent slopes.** This nearly level and gently sloping soil is in lacustrine basins and on terraces. Most areas are irregular in shape and range from 5 to 100 acres in size.

Included with this soil in mapping are some small areas of Zittau soils where the surface layer is silt loam. Some areas of Poy soils are also included.

This soil has high natural fertility and moderate organic-matter content. The effective rooting depth is limited by the water table or, in drained areas, by the sandy substratum. Runoff is very slow. Wetness is the main limitation to use of this soil. Suitable drainage can

practices that will overcome the soil limitations can be planned.

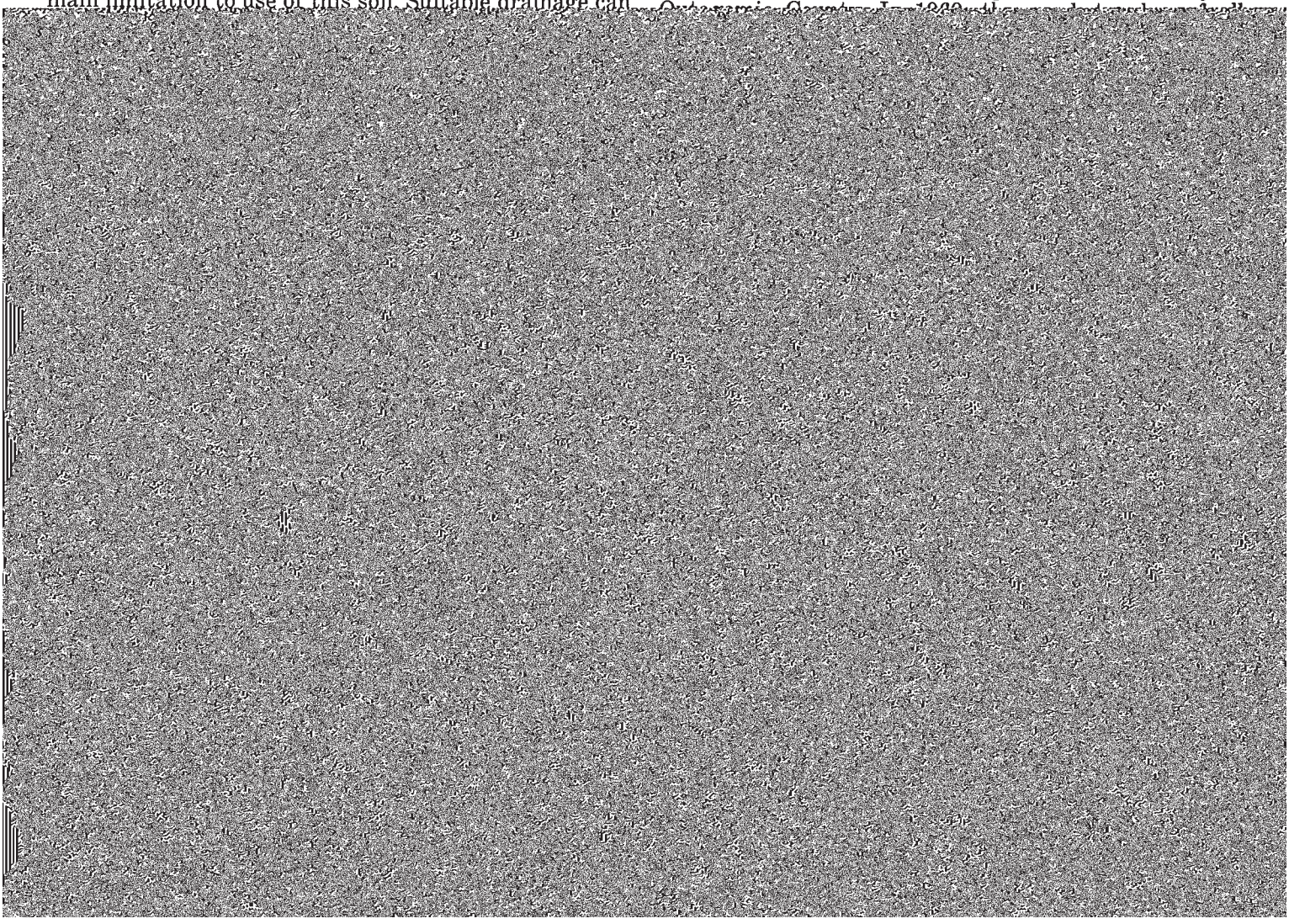
Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

## Management for Crops and Pasture

Agriculture is an important part of the economy of



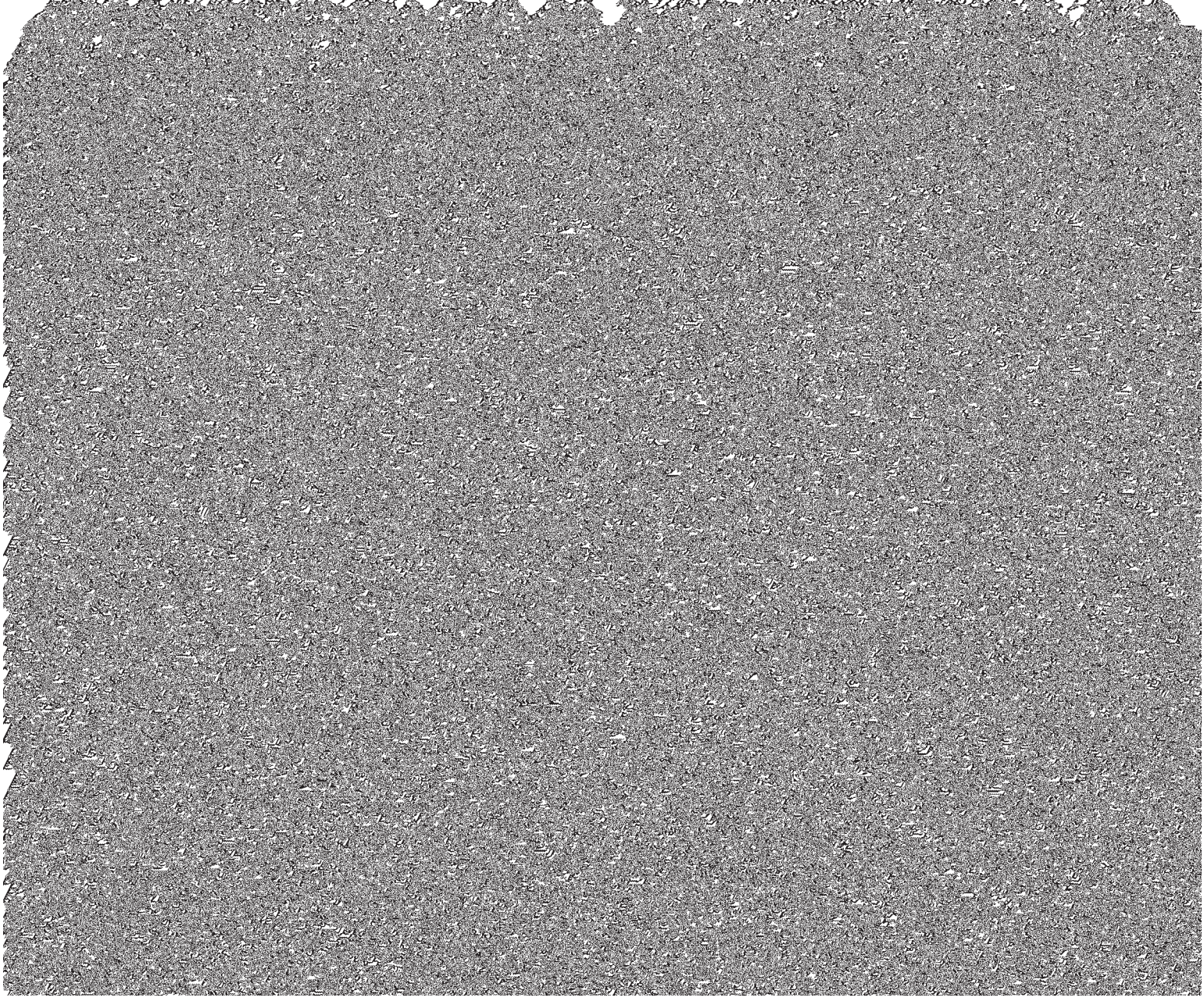
stock, machinery and related equipment, labor requirements, and available capital.

The following paragraphs discuss the basic practices of good soil management as they apply to the survey area. Such basic practices are needed for maintaining good soil structure, tilth, and fertility; for providing drainage and controlling erosion; for selecting a suitable cropping system; and for pasture management. Consideration should also be given to the practices suggested in the capability units. Technical assistance in planning and applying practices suitable for the soils on a particular farm can be obtained from a local representative of the Soil Conservation Service or of the Extension Service.

*Soil structure and tilth.*—Soils that have good structure and tilth take in and hold more available water than soils in which tilth has been destroyed by plowing. Good tilth also helps decrease runoff and erosion. It provides a favorable seedbed where soils have granular

plant litter and organic matter, which reduces erosion and promotes good tilth. Heavy applications of lime and potassium are usually needed for alfalfa, hay, and pasture. Changes in soil acidity affect the availability of plant nutrients. If the soil is neutral, phosphorus and nitrogen are more readily available to plants. Less lime is generally required to neutralize sandy soils, such as the Rousseau and Shawano soils, than to neutralize silty or clayey soils. However, the lime leaches out more quickly from sandy soils, making more frequent applications of lime necessary.

Ratings of available water capacity to a depth of 5 feet of soil or to bedrock are given in the capability unit descriptions and are also listed for each series in the section "Descriptions of the Soils." These ratings are defined in the "Glossary." If the water required by a crop during its peak use period is known, the number of days that a given soil will support the crop without



those of the Deford series, and causing droughtiness. Organic soils, such as those of the Carbondale series, are well suited to both tile and open-ditch drainage, but there is a hazard of frost damage to crops grown on them.

Subsidence is a hazard if organic soils are drained. It lowers the organic soils in Wisconsin approximately ½ to 1 inch a year. The Carbondale soils have a high subsidence potential. Subsidence is caused mainly by loss of ground water buoyancy, consolidation, compaction, and biochemical activity. The first three factors result in initial subsidence, which normally occurs within 3 years after the water table is lowered. Initial subsidence of organic soils typically reduces the thickness of the material above the water table by one-half. Biochemical oxidation of the organic material then causes continued subsidence at a fairly uniform rate until either mineral material or the water table is reached. The rate of subsidence increases with depth to the water table—it can be stopped or slowed by keeping the water level as high as possible for the proposed soil use.

*Controlling erosion.*—The majority of the cultivated soils in the survey area are subject to erosion. The erosion hazard ranges from slight to very severe. There are several methods of controlling erosion on different kinds of soil. One of the most effective methods is maintaining a good vegetative cover, either a growing crop or plant residue from a previous crop. Other practices to be used individually or in various combinations are terracing, contour tillage, contour stripcropping, minimum tillage, use of grassed waterways, and growing a sod cover crop during critical periods of the year. Soil blowing can be controlled by stripcropping at right angles to the prevailing winds, stubble mulching, growing cover crops, and planting shelterbelts.

*Suitable cropping system.*—Soils of the entire farm should be considered when planning a cropping system. Soils that have few or slight limitations can be cropped intensively; that is, row crops can be grown year after year or frequently in relation to hay and small grain. These soils respond well to lime and fertilizer and are capable of producing high yields, and there is little or no erosion hazard. Steep, sandy, or wet soils are more limited in use. A cropping system should be used on these soils that fits the limitations and protects them from damage.

*Managing pasture.*—Good management of pasture is needed to provide high quality forage and to maintain

3. Remove animals when most plants have been grazed to a height of 2 inches.
4. Clip stubble if the pasture has been unevenly grazed or if tall grass is left in bunches that might smother the legumes.
5. Do not graze legume pastures between September 1 and October 10.

The best yields can be maintained for established pasture if the pasture is topdressed, according to needs indicated by a soil test. On grass pasture that contains no legumes, it is beneficial to topdress with nitrogen early in spring and to delay grazing until the grass is 4 inches tall.

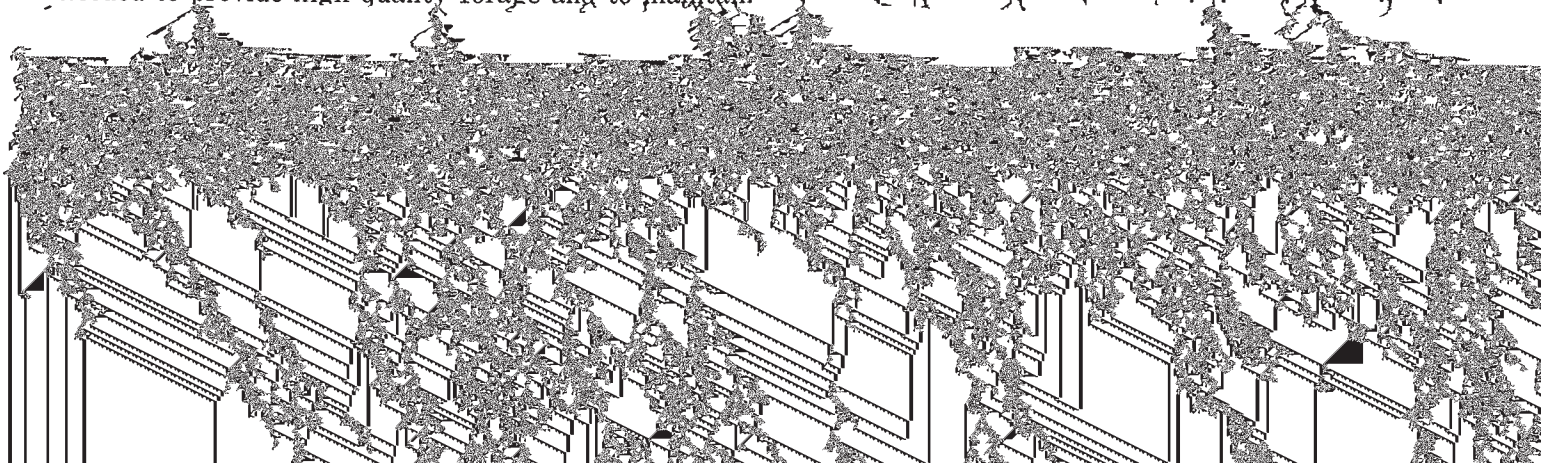
Basic practices needed to improve perennial pasture by seeding of legumes and grasses are as follows:

1. Lime and fertilize according to soil tests. Apply lime, if needed, several months before seeding. Apply fertilizer at the time of seeding.
2. Remove stones or other obstructions, if feasible, to facilitate seedbed preparation and future management.
3. Start preparing the seedbed several months in advance of seeding to eliminate unwanted species and to allow the lime, if applied, to work into the soil.
4. On sloping land, work on the contour and leave mulch on the surface to lessen the hazard of erosion.
5. Inoculate the legume seed.
6. Use small grain in the seeding mixture to aid in erosion control. Graze the nurse crop when it is about 8 to 10 inches high to keep it from competing with young forage plants.
7. Do not graze new seeding when the field is wet or during the month of September. Avoid overgrazing.

Delay spring grazing on wet soils or after heavy rains until the soil becomes firm. Overgrazing sandy soils is hazardous. Because these soils are droughty and produce a relatively thin vegetative cover, overgrazing makes them subject to soil blowing.

### *Capability grouping*

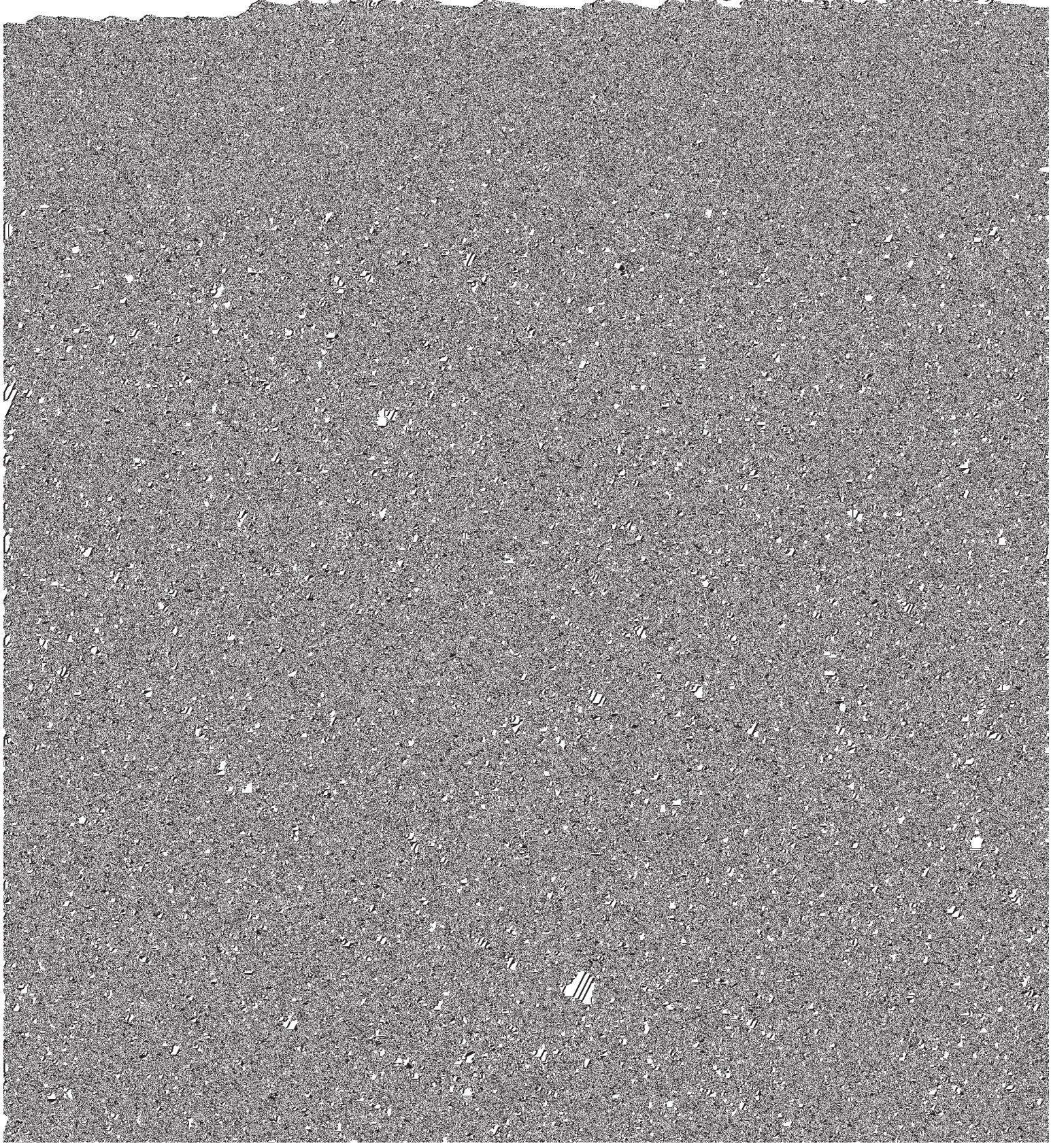
Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops (*9*). The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change



Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderity and low or moderately low organic-matter content. These soils are easy to maintain and have slight limitations.

These soils are well suited to all crops commonly



These soils have moderately slow or slow permeability and moderate to very high available water capacity. They have a low or moderately low organic-matter content and medium or high natural fertility. The hazard of erosion is slight. Maintaining tilth is generally difficult on soils that are eroded.

These soils are used for crops, pasture, and northern hardwood timber. Corn, oats, and alfalfa are the crops commonly grown in the county.

Plowing under crop residue, manuring, and fertilizing help maintain organic-matter content, fertility, and soil tilth. Contour stripcropping, terracing, and the use of waterways help control runoff and erosion. Although not extensively used, the practice of land leveling in combination with field tile or waterways is effective in removing surface water.

#### CAPABILITY UNIT IIw–1

This unit consists of poorly drained, nearly level soils that have a silt loam or silty clay loam surface layer and a firm subsoil. The soils are in drainageways and depressions on glacial till and lacustrine plains.

These soils have moderate or slow permeability and moderate or high available water capacity. They have high organic-matter content and natural fertility. These soils have a high water table and are subject to frequent flooding. Soil tilth is difficult to maintain.

These soils are suited to crop production if flood protection and adequate drainage are provided. Corn is the main crop, but some oats and hay are also grown. Unimproved areas are best suited to late summer pasture, wildlife habitat, or woodland.

Surface drainage and tile drainage are used to remove excess water. Diversions are used to provide some protection from overflow. Plowing under crop residue, manuring, and fertilizing help maintain organic-matter content, fertility, and soil tilth.

#### CAPABILITY UNIT IIw–2

This unit consists mainly of somewhat poorly drained, nearly level and gently sloping soils that have a silt loam or silty clay loam surface layer and a friable to firm subsoil. These soils are in depressions and drainageways on glacial till and lacustrine plains and in areas of the county where limestone bedrock is relatively near the surface.

These soils have high natural fertility and moderate or high organic-matter content. They have low or high available water capacity and moderate to slow permeability. These soils have a high water table and are subject to occasional flooding.

These soils are well suited to continuous row crops if adequate drainage and protection from stream overflow are provided. Corn, oats, and hay are the crops commonly grown in the county. Undrained areas are used for pasture, wildlife habitat, or woodland.

Manuring, leaving crop residue on the soil and

level and gently sloping soils that have a silt loam surface layer. These soils are on broad lacustrine plains.

These soils have high available water capacity, natural fertility, and organic-matter content. They have moderate or moderately slow permeability. These soils have a high water table and are subject to occasional flooding.

Cabbage, peas, snap beans, table beets, and sweet corn are the crops commonly grown on these soils; but corn and hay are also grown. Undrained areas are used for pasture, wildlife habitat, or woodland.

Surface drainage is used to remove excess water; dikes and diversions are used to provide flood protection. Manuring, fertilizing, and plowing under crop residue help maintain soil tilth, fertility, and organic-matter content.

#### CAPABILITY UNIT IIw–5

This unit consists of somewhat poorly drained and poorly drained, nearly level and gently sloping soils that have a silt loam or silty clay loam surface layer and friable or firm subsoil. These soils are on outwash plains.

These soils have low or moderate available water capacity. They have moderate or high organic-matter content and high natural fertility. Permeability is moderate or slow in the subsoil and rapid in the substratum. These soils have a high water table and are subject to occasional flooding.

Corn and hay are the main crops commonly grown in the county. Unprotected areas are generally suited to pasture, wildlife habitat, or woodland.

Minimum tillage, leaving crop residue on the soil, manuring, and fertilizing help maintain organic-matter content, fertility, and soil structure. Diversions are used to provide protection from flooding; surface drainage helps remove excess water.

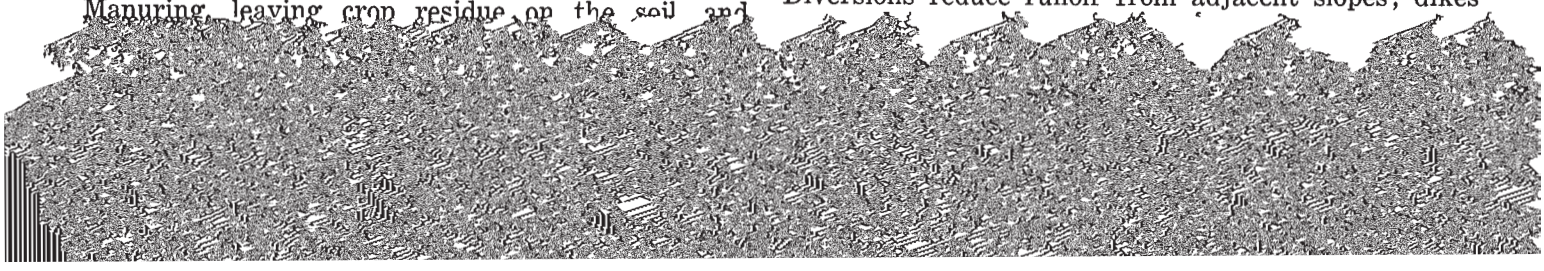
#### CAPABILITY UNIT IIw–11

This unit consists of well drained to somewhat poorly drained, nearly level and gently sloping soils that have mainly a silt loam surface layer. These soils are on stream benches and alluvial bottoms that are subject to stream overflow.

These soils have moderate or high available water capacity. They have moderate organic-matter content and high natural fertility. Permeability is moderate or varies too much to rate. These soils are subject to frequent flooding.

These soils are suited to all crops commonly grown in the county if adequate flood protection is provided. They are used for pasture, wildlife habitat, or woodland if intensive management is not used.

Manuring, fertilizing, leaving crop residue on the soil, and minimum tillage are practices that maintain organic-matter content, fertility, and soil structure. Diversions reduce runoff from adjacent slopes; dikes



These soils have moderately slow to very slow permeability and moderate to very high available water capacity. They have moderately low or low organic-matter content and high natural fertility. Maintaining good tilth is generally difficult on the soils in this unit that have a silty clay loam surface layer.

Corn is the main crop, but oats and alfalfa are also grown. These soils can produce good pasture.

Plowing down crop residue, manuring, and fertilizing help maintain the organic-matter content, fertility, and good tilth of the soil.

#### CAPABILITY UNIT IIIe–1

This unit consists of well drained, sloping soils that have a fine sandy loam or silt loam surface layer. These soils are on glacial till plains or in areas of the county where limestone is relatively near the surface.

These soils have low organic-matter content and medium or high natural fertility. They have moderate or moderately slow permeability and moderate or high available water capacity. The hazard of erosion is moderate.

These soils are suitable for crops commonly grown in the county. They are also suitable for pasture and hardwood timber production.

Minimum tillage, leaving crop residue on the soil, manuring, and fertilizing help maintain the organic-matter content, fertility, moisture, and structure of the soil. Contour stripcropping, terracing, crop rotation, and the use of grassed waterways help control runoff and erosion.

#### CAPABILITY UNIT IIIe–2

This unit consists of well drained and moderately well drained, sloping soils that have a loam or silt loam surface layer and a firm subsoil. These soils are on till plains that, in places, are relatively shallow to limestone bedrock.

These soils have low organic-matter content and medium natural fertility. They have low or high available water capacity and moderate to moderately slow or slow permeability. The hazard of erosion is moderate. The soil that is underlain by bedrock is slightly subject to drought. If properly managed, these soils are fairly easy to maintain in good tilth.

These soils are suitable for all crops commonly grown in the county. Corn, oats, and hay are the main crops. These soils are also suitable for pasture and hardwood timber.

Minimum tillage, leaving crop residue on the soil, manuring, and fertilizing help maintain the organic-matter content, fertility, moisture, and structure of the soil. Contour stripcropping, terracing, crop rotation, and the use of waterways help control runoff and erosion.

#### CAPABILITY UNIT IIIe–3

This unit consists of well drained and somewhat excessively drained, gently sloping soils that have a loam or silt loam surface layer. These soils are on outwash plains or glacial till plains in areas of the county where limestone bedrock is relatively close to the surface.

These soils have moderate permeability and low organic-matter content and low or medium natural fertility. Water erosion is a slight hazard, and drought is a moderate to severe hazard.

These soils are suited to the more drought-resistant hay crops and to crops, such as oats, that mature before the hot, dry part of the summer. Some corn is also grown. These soils are also suited to pasture and some hardwood timber.

Leaving crop residue on the soil, manuring, and fertilizing help maintain the organic-matter content, fertility, and moisture of the soil. Contour stripcropping, crop rotation, and the use of grassed waterways help control runoff and erosion.

#### CAPABILITY UNIT IIIe–4

This unit consists of well drained and moderately well drained, gently sloping soils that have a loamy fine sand or fine sandy loam surface layer. These soils are on glacial till plains.

These soils have rapid permeability in the upper sandy layer and moderate or slow permeability in the substratum. They have low organic-matter content and low natural fertility and moderate available water capacity. The hazard of erosion is slight. These soils are subject to blowing and are moderately droughty.

These soils are best suited to the more drought-resistant hay crops and to crops, such as oats, that mature before the hot, dry part of the summer. Some corn is also grown. These soils are well suited to pasture in early spring or late fall. Pines grow well on these soils.

Plowing under crop residue, manuring, and fertilizing help maintain the organic-matter content, fertility, and moisture of the soil. Stripcropping, crop rotations, the use of waterways, and shelterbelts reduce runoff and erosion and control soil blowing.

#### CAPABILITY UNIT IIIe–6

This unit consists of well drained and moderately well drained, sloping soils that have a silt loam or silty clay loam surface layer and a firm subsoil. These soils are on glacial till or lacustrine plains.

These soils have moderately slow to very slow permeability and moderate available water capacity. They have low or moderately low organic-matter content and high natural fertility. The hazard of erosion is moderate except if the soils are in pasture or woodland. Maintaining good tilth is difficult in some areas of these soils because of the high percentage of clay.

These soils are suited to all crops commonly grown in the county.

Plowing under crop residue, manuring, and fertilizing help maintain the tilth, organic-matter content, and fertility of the soil. Contour stripcropping, crop rotation, and the use of waterways control runoff and erosion.

#### CAPABILITY UNIT IIIe–7

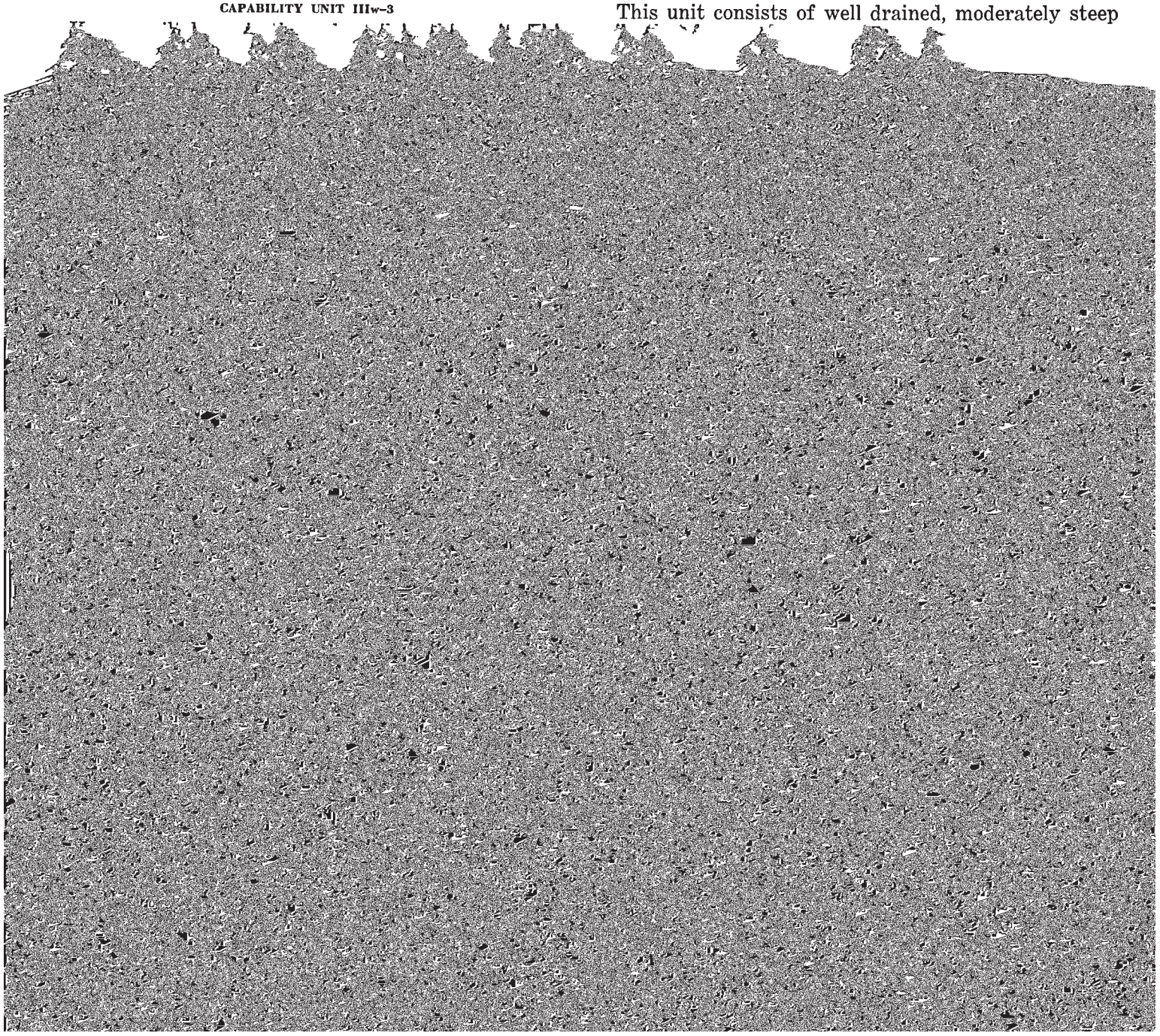
This unit consists of well drained and somewhat excessively drained, sloping and moderately steep soils that have a fine sandy loam or loamy sand surface layer. These soils are on outwash plains or till plains where sandstone bedrock is relatively close to the surface.

permeability and low or moderate available water capacity. They have low organic-matter content and low natural fertility. These soils are moderately droughty and are subject to blowing. The hazard of erosion is moderate.

These soils are suited to the more drought-resistant hay crops and to crops, such as oats, that mature before the hot, dry part of the summer. They are also suited to pasture. Pines grow very well on these soils.

Leaving crop residue on the soil, manuring, fertilizing, and minimum tillage help maintain the organic-matter content, fertility, and moisture of the soils. Contour stripcropping and crop rotation control runoff, water erosion, and soil blowing.

CAPABILITY UNIT IIIw–3



low or moderate available water capacity. They have low organic-matter content and low natural fertility. The hazards of drought and soil blowing are moderate, and the hazard of erosion is slight.

These soils are suited to the more drought-resistant crops, such as oats, some hay, and pasture; but some corn is also grown. Pines grow very well on these soils.

Leaving crop residue on the soil, manuring, fertilizing, and minimum tillage help maintain the organic-matter content, fertility, and moisture of the soil. Stripcropping, crop rotation, and the use of waterways and shelterbelts control runoff and erosion, reduce soil blowing, and preserve soil moisture.

CAPABILITY UNIT IVe–2

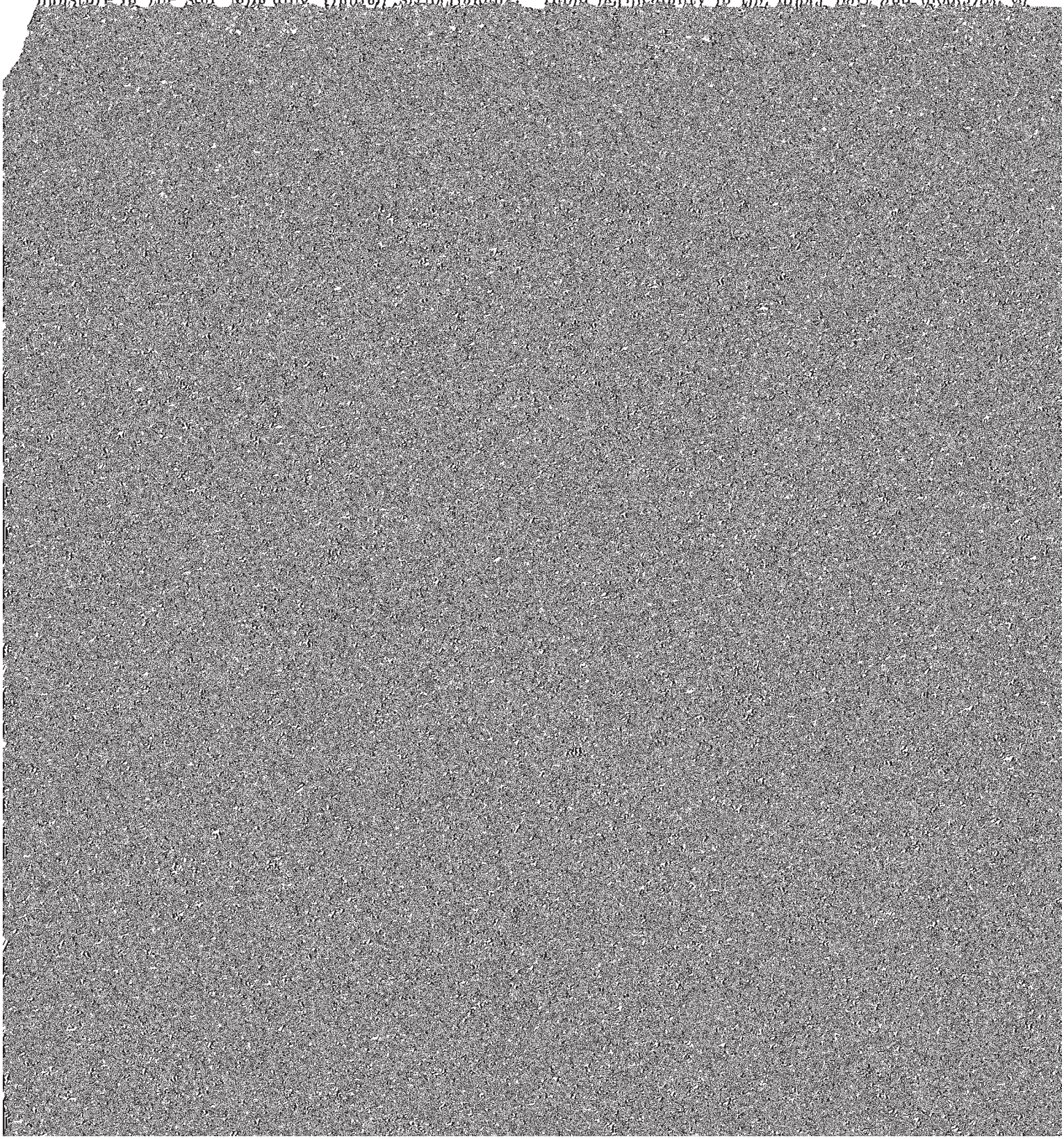
This unit consists of well drained, moderately steep

also well suited to early spring and fall pasture and to hardwoods. Pines grow very well on these soils.

Minimum tillage, fertilizing, and manuring help maintain the organic-matter content, fertility, and moisture of the soil. Mulching, contour stripcropping,

level, organic soils that are underlain by a clayey or loamy substratum. These soils are in old glacial lake basins and depressions.

These soils have moderately slow to moderately rapid permeability in the upper part and moderate to



a good grass cover, which helps prevent flood damage.

CAPABILITY UNIT VIIe-2

*Figure 8.*—This area of Shawano fine sand, hilly, is in capability unit VIIs–9. The light-colored area in the background is an exposed blowout caused by cultivation and overgrazing.

of the soils for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 2 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

## Woodland Management and Productivity [2]

Outagamie County was entirely forested before settlement took place. The northern part was mainly mixed conifer-northern hardwood forest and the south-

type of the commercial forest acreage is classified as follows: conifers, 5,300 acres; oak and hickory, 12,000 acres; elm, ash, and cottonwood, 21,800 acres; maple, beech and birch, 17,300 acres; aspen and paper birch, 8,800 acres; and nonstocked, 3,900 acres (*11*).

A small acreage of land that had once been farmed has been returned to forestry use. Red and white pine have been planted on Shawano and Rousseau soils. Continued reforestation is needed on these sandy soils. These plantings are a significant addition to the soil and water conservation program in Outagamie County because they reduce soil blowing, improve wildlife habitat, and beautify the landscape.

Table 3 contains information useful to woodland owners or forest managers planning use of soils for wood crops. Mapping unit symbols for soils suitable for wood crops are listed, and the ordination (woodland suitability) symbol for each soil is given. All soils

TABLE 2.—*Yields per acre of crops and pasture*

[Yields are those that can be expected under a high level of management. The estimates were made in 1974. Absence of a yield figure indicates that the soil is not suited to the crop or the crop is generally not grown on the soil. Only arable soils are listed]

| Soil name and map symbol | Corn | Corn silage | Oats | Grass-legume hay | Kentucky bluegrass |
|---|---|---|---|---|---|
| | *Bu* | *Ton* | *Bu* | *Ton* | *AUM* [1] |
| Allendale: AdA | 80 | 13 | 60 | 3.5 | 3.3 |
| Angelica: Ax | 105 | 17 | 75 | 3.0 | 3.5 |
| Bellevue: Bc | 100 | 16 | 70 | 4.5 | 3.0 |
| Bonduel: BnA | 80 | 13 | 70 | 3.5 | 3.5 |
| Borth: BoA | 85 | 15 | 75 | 4.5 | 3.0 |
| Boyer: | | | | | |
| BrB | 70 | 12 | 50 | 2.1 | 2.0 |
| BrC2 | 65 | 11 | 45 | 2.1 | 1.6 |
| BrD2 | 50 | 10 | 40 | 1.8 | 1.4 |
| Briggsville: | | | | | |
| BtA | 100 | 16 | 70 | 4.5 | 3.0 |
| BtB | 95 | 15 | 70 | 4.0 | 3.0 |
| Carbondale: Ca | 95 | 16 | ---- | 2.4 | ---- |
| Casco: | | | | | |
| CcB | 70 | 12 | 55 | 2.7 | 3.0 |
| CcC2 | 65 | 11 | 50 | 2.5 | 2.5 |
| CcD2 | ---- | ---- | 40 | 2.0 | 2.5 |
| Cathro: Cm | 50 | 12 | 55 | 2.5 | ---- |
| Channahon: CnB | 60 | 10 | 45 | 2.8 | 2.0 |
| Deford: De | 75 | 10 | 50 | 3.0 | 2.3 |
| Eleva: | | | | | |
| ElB | 70 | 11 | 50 | 3.0 | 2.3 |
| ElC2 | 70 | 11 | 50 | 2.5 | 2.0 |
| Fluvaquents: Fu | ---- | ---- | ---- | ---- | 3.0 |
| Grays: | | | | | |
| GrA | 120 | 20 | 70 | 4.2 | 3.5 |
| GrB | 105 | 18 | 65 | 4.2 | 3.5 |
| Hebron: HeB | 90 | 15 | 70 | 3.5 | 3.0 |
| Hortonville: | | | | | |
| HnB, HrB, HsB | 110 | 17 | 70 | 4.5 | 3.5 |
| HnC2, HrC2, HsC2 | 100 | 16 | 65 | 4.0 | 3.5 |
| HrD2 | 85 | 14 | 55 | 3.5 | 3.0 |
| HrE | ---- | ---- | ---- | 3.0 | 2.5 |
| HtB (both Hortonville and Symco parts) | 104 | 17 | 68 | 4.3 | 2.5 |
| Kaukauna: KaA | 100 | 16 | 80 | 4.5 | 3.0 |
| Keowns: Ke | 90 | 15 | 60 | 3.5 | 3.5 |
| Kewaunee: | | | | | |
| KhB | 110 | 18 | 80 | 4.5 | 3.0 |
| KhC2 | 100 | 17 | 75 | 4.5 | 2.7 |
| KhD2 | 95 | 16 | 60 | 4.0 | 2.5 |
| KkE3 | ---- | ---- | ---- | 2.7 | 1.5 |
| KlB (both Kewaunee and Manawa parts) | 100 | 17 | 75 | 4.5 | 3.5 |
| Kolberg: | | | | | |
| KoB | 80 | 13 | 65 | 3.7 | 3.0 |
| KoC2 | 65 | 11 | 55 | 3.0 | 2.6 |
| Manawa: McA | 90 | 15 | 75 | 4.5 | 3.5 |

See footnote at end of table.

TABLE 2.—*Yields per acre of crops and pasture*—Continued

| Soil name and map symbol | Corn | Corn silage | Oats | Grass-legume hay | Kentucky bluegrass |
|---|---|---|---|---|---|
| | *Bu* | *Ton* | *Bu* | *Ton* | *AUM* [1] |
| Manistee: | | | | | |
| MeB, MfB | 70 | 13 | 60 | 3.0 | 2.5 |
| MeC2 | 65 | 12 | 55 | 2.7 | 2.4 |
| Markey: Mk | 75 | 12 | 60 | 2.5 | ---- |
| Menominee: | | | | | |
| MsB | 70 | 12 | 50 | 3.0 | 2.6 |
| MsC2 | 60 | 10 | 45 | 2.7 | 2.3 |
| Mosel: MtA | 105 | 17 | 60 | 4.5 | 3.0 |
| Mundelein: MuA | 120 | 19 | 80 | 4.5 | 3.0 |
| Namur: NaB | ---- | ---- | 25 | 2.0 | 2.0 |
| Nichols: | | | | | |
| NfA | 95 | 16 | 70 | 4.0 | 3.0 |
| NfB, NsA, NsB | 90 | 15 | 65 | 4.0 | 3.0 |
| Onaway: | | | | | |
| OhB | 90 | 15 | 75 | 4.0 | 3.0 |
| OhC2 | 80 | 14 | 65 | 3.8 | 2.7 |
| OhD2 | 70 | 10 | 55 | 3.8 | 2.4 |
| OlB (both Onaway and Solona parts.) | 90 | 15 | 75 | 4.0 | 3.0 |
| Pella: Pe | 120 | 19 | 75 | 4.8 | 3.0 |
| Poy: Pf | 90 | 15 | 65 | 4.0 | 3.0 |
| Poygan: Po | 100 | 17 | 65 | 4.0 | 3.0 |
| Rondeau: Rd | 65 | 11 | 50 | ---- | ---- |
| Rousseau: RoB | 50 | 8 | 40 | 2.5 | 2.0 |
| Shawano: | | | | | |
| SeC | ---- | ---- | 30 | 1.5 | 2.0 |
| SeD | ---- | ---- | ---- | ---- | 1.7 |
| Shiocton: | | | | | |
| ShA | 100 | 16 | 55 | 3.0 | 3.0 |
| SkA | 110 | 18 | 65 | 4.0 | 3.0 |
| SnB (both Shiocton and Nichols parts) | 90 | 15 | 65 | 3.7 | 3.0 |
| Solona: SoA | 100 | 16 | 70 | 4.0 | 3.5 |
| Suamico: Su | 50 | 12 | 55 | 2.5 | ---- |
| Symco: SyA | 90 | 18 | 65 | 4.0 | 3.5 |
| Symco variant: SzA | 90 | 15 | 65 | 4.0 | 3.5 |
| Udifluvents: Uf | 60 | 10 | 60 | 3.5 | 3.3 |
| Udorthents: Uo | ---- | ---- | ---- | ---- | 2.3 |
| Wainola: WaA | 75 | 12 | 65 | 3.0 | 2.5 |
| Will: Wb | 105 | 17 | 65 | 4.5 | 3.0 |
| Winneconne: | | | | | |
| WnA | 90 | 15 | 80 | 5.0 | 3.5 |
| WnB | 85 | 14 | 75 | 5.0 | 3.5 |
| WnC2 | 80 | 13 | 70 | 4.5 | 3.0 |
| Zittau: ZtA | 90 | 15 | 65 | 4.0 | 3.5 |

[1] Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for a period of 30 days.

*Figure 9.*—**This stand of white pine is on Onaway soils in the northern part of the county.**

the soil into a limitation class is in the following order: w, d, c, s, and r.

In table 3 the soils are also rated for a number of factors to be considered in management. *Slight, moderate,* and *severe* are used to indicate the degree of major soil limitations.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or equipment; *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

*Seedling mortality* ratings indicate the degree that the soil affects expected mortality of planted tree seedlings. Plant competition is not considered in the ratings. Seedlings from good planting stock that are properly planted during a period of sufficient rainfall are rated. A rating of *slight* indicates that the expected mortality of the planted seedlings is less than 25 percent; *moderate,* 25 to 50 percent; and *severe,* more than 50 percent.

Considered in the ratings of *windthrow hazard* are characteristics of the soil that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that trees in wooded areas are not expected to be blown down by commonly occurring winds; *moderate,* that some trees are blown down during periods of excessive soil wetness and strong winds; and *severe,* that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade or grow if openings are made in the tree canopy. The invading plants compete with native plants or planted seedlings by impeding or preventing their growth. A

*Figure 10.*—Tree growth is poor on Namur soils, which are shallow and very shallow to limestone bedrock.

rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* means that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed for the control of undesirable plants.

The *potential productivity* of merchantable or *important trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Important trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

*Trees to plant* are those that are suitable for commercial wood production and that are suited to the soils.

## Windbreaks and Environmental Plantings

Windbreaks are established to protect livestock, buildings, and yards from wind and snow. Windbreaks also help protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous species provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field, the interval depending on erodibility of the soil. They protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. A healthy planting stock of suitable species planted properly on a well prepared site and maintained in good condition can insure a high degree of plant survival.

TABLE 3.—*Woodland management and productivity*

[Only the soils suitable for production of commercial trees are listed in this table. Absence of an entry in a column means the information was not available]

| Soil name and map symbol | Ordination symbol | Management concerns | | | | Potential productivity | | Trees to plant |
|---|---|---|---|---|---|---|---|---|
| | | Equipment limitation | Seedling mortality | Windthrow hazard | Plant competition | Important trees | Site index | |
| Allendale: AdA. | 3w | Moderate | Severe | Slight | Slight | Quaking aspen<br>White ash<br>Swamp white oak<br>Eastern white pine<br>White spruce<br>Paper birch<br>Eastern white pine<br>Balsam fir | 60 | White spruce, eastern white pine. |
| Angelica: Ax | 4w | Severe | Severe | Severe | Slight | Balsam fir<br>Quaking aspen<br>Northern white-cedar.<br>Black ash | 45 | White ash, northern white-cedar. |
| Bellevue: Bc | 3o | Slight | Slight | Slight | Slight | Northern red oak<br>Sugar maple | 58 | Eastern white pine, red pine, white spruce. |
| Bonduel: BnA | 3o | Slight | Slight | Slight | Moderate | Northern white-cedar.<br>Quaking aspen<br>Paper birch | 35 | Poplars, white spruce. |
| Borth: BoA | 3c | Slight | Slight | Moderate | Slight | White ash<br>Sugar maple<br>Northern pin oak<br>American basswood | 55 | Red pine, eastern white pine. |
| Boyer: BrB, BrC2, BrD2. | 2s | Slight | Slight | Slight | Moderate | Northern red oak<br>White oak<br>American basswood<br>Northern pin oak | 66 | Eastern white pine, red pine. |
| Briggsville: BtA, BtB. | 2c | Slight | Slight | Slight | Moderate | Sugar maple<br>Northern red oak<br>White oak<br>American basswood | 58 | Eastern white pine, white spruce, black spruce. |
| Carbondale: Ca. | 3w | Severe | Severe | Severe | Severe | Balsam fir<br>Northern white-cedar.<br>Tamarack | 55<br>34<br>45 | |
| Casco: CcB, CcC2 | 3s | Slight | Slight | Slight | Slight | Northern red oak<br>Black oak<br>White oak | 55 | Red pine, eastern red-cedar. |
| CcD2 | 3s | Moderate | Slight | Slight | Slight | Northern red oak<br>Black oak<br>White oak<br>American basswood<br>Sugar maple | 55 | Red pine, jack pine. |
| Cathro: Cm | 3w | Severe | Severe | Severe | Severe | Balsam fir<br>Tamarack<br>Northern white-cedar.<br>Red maple<br>White ash | 50 | |

TABLE 3.—*Woodland management and productivity*—Continued

| Soil name and map symbol | Ordination symbol | Management concerns | | | | Potential productivity | | Trees to plant |
|---|---|---|---|---|---|---|---|---|
| | | Equipment limitation | Seedling mortality | Windthrow hazard | Plant competition | Important trees | Site index | |
| Thaxton: | | | | | | | | |

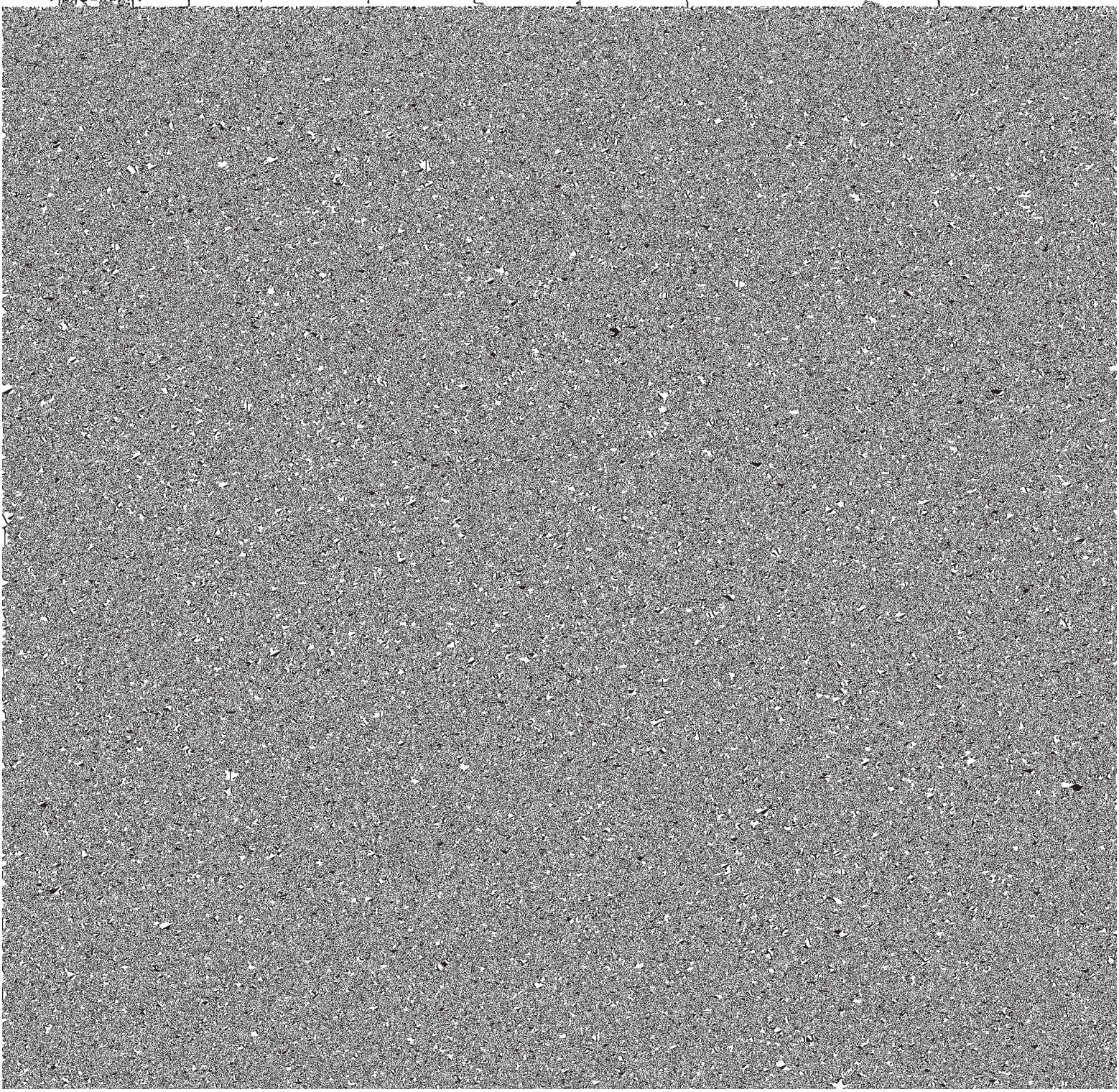


TABLE 3.—*Woodland management and productivity*—Continued

| Soil name and map symbol | Ordination symbol | Management concerns | | | | Potential productivity | | Trees to plant |
|---|---|---|---|---|---|---|---|---|
| | | Equipment limitation | Seedling mortality | Windthrow hazard | Plant competition | Important trees | Site index | |
| Kewaunee: KhB, KhC2, KlB, | 2c | Slight | Slight | Slight | Moderate | Northern red oak, Sugar maple | 66 | Eastern white pine, red pine, |

TABLE 3.—*Woodland management and productivity*—Continued

| Soil name and map symbol | Ordination symbol | Management concerns | | | | Potential productivity | | Trees to plant |
|---|---|---|---|---|---|---|---|---|
| | | Equipment limitation | Seedling mortality | Windthrow hazard | Plant competition | Important trees | Site index | |
| Nichols: NfA, NfB | 1o | Slight | Slight | Slight | Moderate | Sugar maple<br>Northern red oak<br>American basswood<br>White oak | 66 | Red pine, eastern white pine, white spruce. |
| NsA, NsB | 1o | Slight | Slight | Slight | Moderate | Northern red oak<br>Sugar maple<br>White ash<br>American basswood | 70<br>65 | Eastern white pine, red pine, white spruce. |
| Onaway: OhB, OhC2, OhD2, OlB. For Solona part of OlB, see Selona series. | 2d | Slight | Slight | Slight | Moderate | Sugar maple<br>Quaking aspen<br>Yellow birch<br>Northern red oak<br>Red pine<br>American basswood<br>White ash | 61 | White spruce, eastern white pine. |
| Pella: Pe | 3w | Moderate | Moderate | Moderate | Slight | Northern white-cedar.<br>Black ash<br>Tamarack<br>Red maple | 33 | Black spruce, white spruce. |
| Poy: Pf | 2w | Moderate | Moderate | Slight | Moderate | Red maple<br>Silver maple<br>American basswood<br>American elm<br>White ash<br>Green ash | 65 | Red maple, silver maple, white ash, green ash. |
| Poygan: Po | 2w | Severe | Severe | Moderate | Severe | White ash<br>Red maple | 65 | White spruce, black spruce, red maple, white ash. |
| Rondeau: Rd | 5w | Severe | Severe | Severe | Severe | Northern white-cedar.<br>Tamarack | 33 | |
| Rousseau: RoB. | 2s | Slight | Severe | Slight | Moderate | Sugar maple<br>Red maple<br>Balsam fir<br>Northern red oak<br>Eastern white pine<br>Red pine<br>Jack pine<br>Black oak | 61<br><br><br>70<br>65<br>65<br>55<br>66 | Red pine, jack pine, white spruce. |
| Shawano: SeC | 2s | Slight | Severe | Slight | Moderate | Northern red oak<br>Red pine<br>Eastern white pine<br>Red maple<br>Paper birch | 66<br>62<br>66 | Red pine, eastern white pine. |
| SeD | 2s | Moderate | Severe | Slight | Moderate | Northern red oak<br>Red pine<br>Eastern white pine<br>Red maple<br>Paper birch | 66<br>62<br>66 | Red pine, eastern white pine. |

TABLE 3.—*Woodland management and productivity*—Continued

| Soil name and map symbol | Ordination symbol | Management concerns | | | | Potential productivity | | Trees to plant |
|---|---|---|---|---|---|---|---|---|
| | | Equipment limitation | Seedling mortality | Windthrow hazard | Plant competition | Important trees | Site index | |
| Shiocton: ShA, SnB—For Nichols part of SnB, see NfA and NfB in Nichols series. | 1o | Slight | Slight | Slight | Moderate | Red maple<br>Sugar maple<br>Northern red oak<br>American basswood<br>American beech | 70 | Eastern white pine, white spruce, silver maple, white ash. |
| SkA | 1o | Slight | Slight | Slight | Moderate | Red maple<br>Sugar maple<br>Northern red oak<br>American basswood<br>American beech | 70 | Eastern white pine, white spruce, red maple, white ash. |
| Solona: SoA | 2o | Slight | Slight | Slight | Moderate | Sugar maple<br>Northern red oak<br>White ash<br>American basswood | 63<br>68 | Eastern white pine, red pine, white spruce. |
| Suamico: Su. | 3w | Severe | Severe | Severe | Severe | Northern white-cedar.<br>Tamarack<br>Red maple<br>White ash | 35 | |
| Symco: SyA | 1o | Slight | Slight | Slight | Moderate | White ash<br>Green ash<br>Northern red oak<br>Sugar maple<br>American basswood | 75 | Red maple, silver maple, white ash, green ash, white spruce. |
| Symco variant: SzA. | 2w | Moderate | Slight | Slight | Severe | Northern red oak<br>Bitternut hickory<br>White ash<br>American basswood<br>Sugar maple | 66 | White spruce, Norway spruce, eastern white pine, northern white-cedar. |
| Udifluvents: Uf. | 3o | Slight | Slight | Slight | Slight | Northern red oak<br>White ash<br>Red maple | 55 | Eastern white pine, red pine, white spruce. |
| Udorthents: Uo. | | | | | | | | Eastern white pine, red pine. |
| Wainola: WaA. | 3w | Moderate | Severe | Slight | Slight | White ash<br>Red maple<br>Sugar maple<br>Northern red oak | 60 | White spruce, Norway spruce, eastern white pine. |
| Will: Wb | 4w | Moderate | Moderate | Moderate | Severe | Red maple<br>White ash<br>Swamp white oak | 50 | Black spruce, white spruce, white ash, red maple. |
| Winneconne: WnA, WnB, | 2c | Slight | Slight | Slight | Moderate | Northern red oak | 65 | Eastern white |

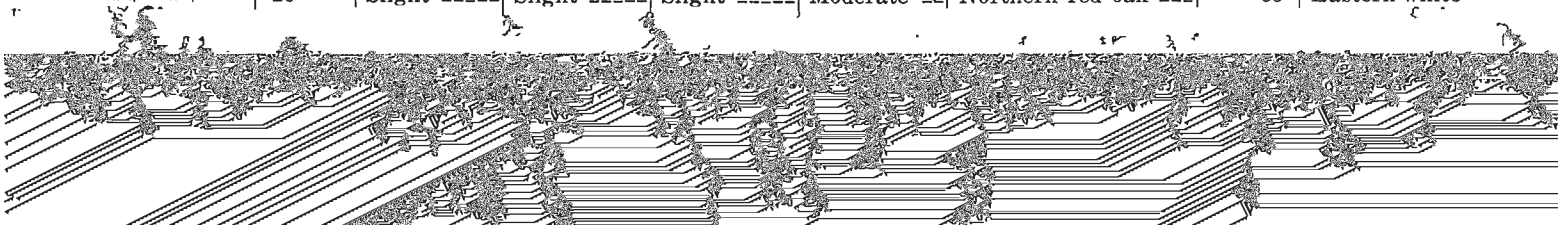


TABLE 4.—*Windbreaks and environmental plantings*

[Gravel pits (Gp), Limestone quarries (Ln), and Rock outcrop (Ra) are not listed. Dashes indicate that trees generally do not grow to the given height on that soil]

| Soil name and map symbol | Trees having predicted 20-year average heights of— | | | | |
|---|---|---|---|---|---|
| | less than 8 feet | 8 to 15 feet | 16 to 25 feet | 26 to 35 feet | More than 35 feet |
| Allendale: AdA | | White spruce, American cranberry-bush, silky dogwood. | Black spruce, northern white-cedar, tall purple willow. | | |
| Angelica: Ax | | White spruce, silky dogwood. | Northern white-cedar, black spruce. | | Carolina poplar. |
| Bellevue: Bc | | Northern white-cedar, lilac, common ninebark, silky dogwood. | White spruce, Norway spruce. | Eastern white pine, red pine. | |
| Bonduel: BnA | | Northern white-cedar, redosier dogwood, nannyberry viburnum. | Green ash, white spruce. | Eastern white pine, jack pine, silver maple. | |
| Borth: BoA | Silky dogwood | Common ninebark, northern white-cedar, lilac. | White spruce, Norway spruce. | Eastern white pine, red pine. | |
| Boyer: BrB, BrC2, BrD2 | | Autumn-olive, Vanhoutte spirea, Tatarian honeysuckle, Amur privet. | Red pine | Eastern white pine, jack pine. | |
| Briggsville: BtA, BtB | | Northern white-cedar, lilac, common ninebark, silky dogwood. | White spruce, Norway spruce. | Eastern white pine, red pine. | |
| Carbondale: Ca | | Black spruce, silky dogwood. | Austrian pine, nannyberry viburnum. | Northern white-cedar, Scotch pine. | |
| Casco: CcB, CcC2, CcD2 | | Northern white-cedar, lilac, common ninebark, silky dogwood. | White spruce, Norway spruce. | Eastern white pine, red pine. | |
| Cathro: Cm | | Tatarian honeysuckle, silky dogwood, white spruce. | Austrian pine, laurel willow. | Northern white-cedar, eastern white pine. | |
| Channahon: CnB | | Autumn-olive, eastern red-cedar. | Russian-olive | Eastern white pine, red pine. | |
| Deford: De | | Nannyberry viburnum, arrowwood. | Northern white-cedar, eastern white pine, black spruce. | | |
| Eleva: ElB, ElC2 | Manyflower cotoneaster. | Lilac | Norway spruce, Siberian peashrub. | Eastern white pine, red pine, jack pine. | |

TABLE 4.—*Windbreaks and environmental plantings*—Continued

| Soil name and map symbol | Trees having predicted 20-year average heights of— | | | | |
|---|---|---|---|---|---|
| | less than 8 feet | 8 to 15 feet | 16 to 25 feet | 26 to 35 feet | More than 35 feet |
| Fluvaquents: Fu | | Northern white-cedar, redosier dogwood, nannyberry viburnum. | Green ash, white spruce. | Eastern white pine, jack pine, silver maple. | |
| Grays: GrA, GrB | | Silky dogwood, Amur maple, Amur honeysuckle, lilac. | Autumn-olive, Russian-olive, white spruce. | Eastern white pine, red pine, Douglas-fir. | Norway spruce. |
| Hebron: HeB | | Northern white-cedar, lilac, common ninebark, silky dogwood. | White spruce, Norway spruce. | Eastern white pine, red pine. | |
| Hortonville: HnB, HnC2, HrB, HrC2, HrD2, HrE, HsB, HsC2, HtB. For Symco part of HtB, see Symco series. | | Northern white-cedar, common ninebark, silky dogwood, lilac. | White spruce, Norway spruce. | Eastern white pine, red pine. | |
| Kaukauna: KaA | | Northern white-cedar, common ninebark, silky dogwood, lilac. | White spruce, Norway spruce. | Eastern white pine, red pine. | |
| Keowns: Ke | | Northern white-cedar, redosier dogwood, nannyberry viburnum. | Green ash, white spruce. | Eastern white pine, jack pine, silver maple. | |
| Kewaunee: KhB, KhC2, KhD2, KkE3, KlB For Manawa part of KlB, see Manawa series. | | Northern white-cedar, lilac, common ninebark, silky dogwood. | White spruce, Norway spruce. | Eastern white pine, red pine. | |
| Kolberg: KoB, KoC2 | | Northern white-cedar, common ninebark, silky dogwood, lilac. | White spruce, Norway spruce. | Eastern white pine, red pine. | |
| Lobo: Lo. | | | | | |
| Manawa: McA | | Northern white-cedar, lilac, common ninebark, silky dogwood. | White spruce, Norway spruce. | Eastern white pine, red pine. | |
| Manistee: MeB, MeC2, MfB | | | Red pine, American mountainash, Siberian crabapple, hawthorn. | | |
| Markey: Mk | | Silky dogwood | Austrian pine, laurel willow. | Eastern white pine, Scotch pine, northern white-cedar. | |
| Menominee: MsB, MsC2 | | Northern white-cedar, lilac, common ninebark, silky dogwood. | White spruce, Norway spruce. | Eastern white pine, red pine. | |

TABLE 4.—*Windbreaks and environmental plantings*—Continued

| Soil name and map symbol | Trees having predicted 20-year average heights of— | | | | |
|---|---|---|---|---|---|
| | less than 8 feet | 8 to 15 feet | 16 to 25 feet | 26 to 35 feet | More than 35 feet |
| Mosel: MtA | | Northern white-cedar, nannyberry viburnum, redosier dogwood. | White spruce, green ash. | Eastern white pine, jack pine, silver maple. | |
| Mundelein: MuA | | Autumn-olive, Amur honeysuckle, lilac. | Russian-olive | Eastern white pine, Norway spruce, Douglas fir | |

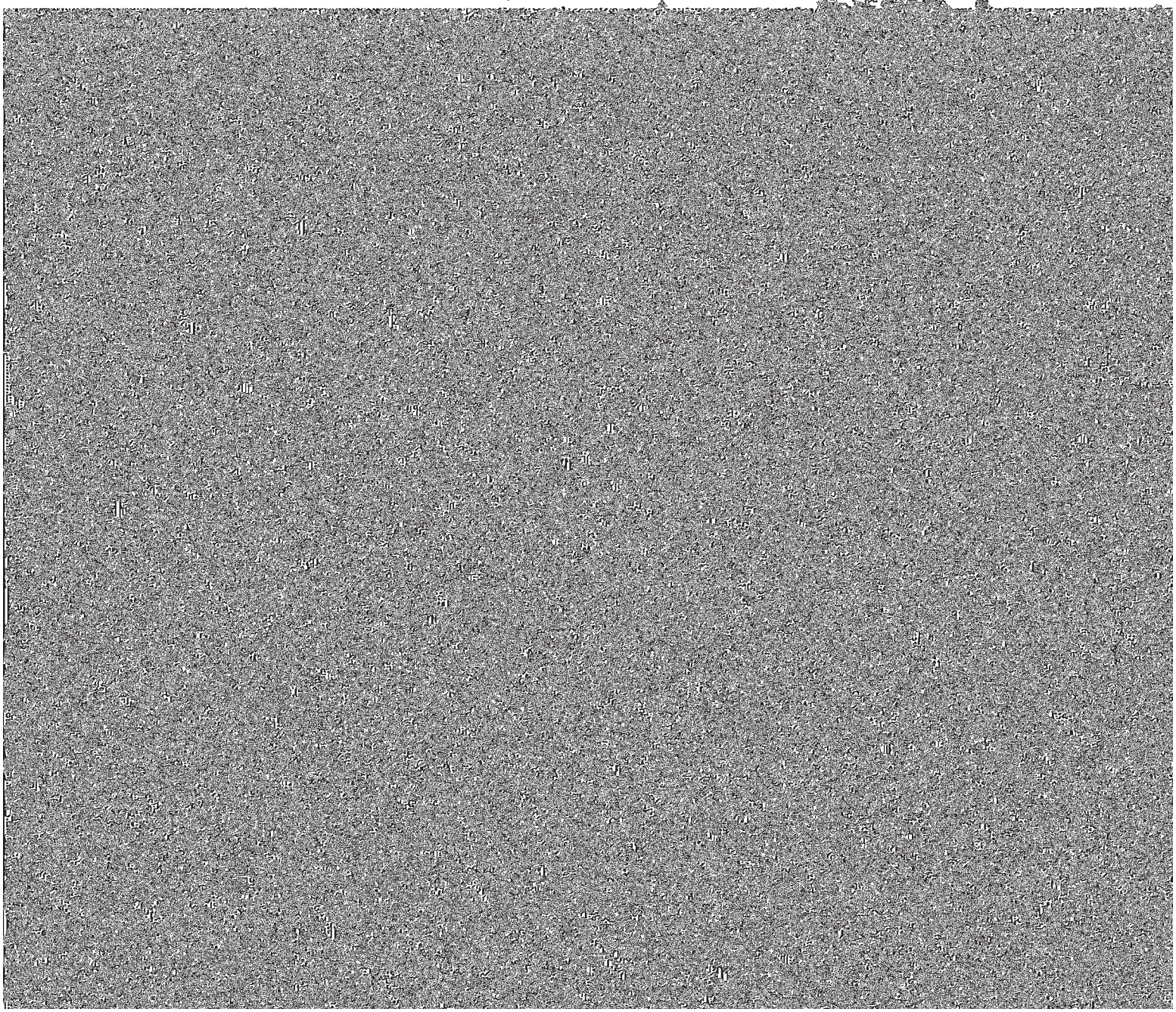


TABLE 4.—*Windbreaks and environmental plantings*—Continued

| Soil name and map symbol | Trees having predicted 20-year average heights of— | | | | |
|---|---|---|---|---|---|
| | less than 8 feet | 8 to 15 feet | 16 to 25 feet | 26 to 35 feet | More than 35 feet |
| Solona: SoA | | Northern white-cedar, redosier dogwood, nannyberry viburnum. | Green ash, white spruce. | Eastern white pine, jack pine, silver maple. | |
| Suamico: Su | | Late lilac, nannyberry viburnum, common ninebark. | Japanese tree lilac. | Laurel willow | Carolina poplar, almondleaf willow. |
| Symco: SyA | Redosier dogwood, silky dogwood. | Northern white-cedar, American cranberry-bush, lilac. | White spruce, black spruce. | Eastern white pine, red pine. | Red maple, white ash, green ash. |
| Symco variant: SzA | | Northern white-cedar, redosier dogwood, nannyberry viburnum. | Green ash, white spruce. | Eastern white pine, jack pine, silver maple. | |
| Udifluvents: Uf | | Lilac | White spruce, green ash. | Eastern white pine, jack pine. | |
| Udorthents: Uo | | Northern white-cedar, lilac, common ninebark, silky dogwood. | White spruce, Norway spruce. | Eastern white pine, red pine. | |
| Wainola: WaA | | White spruce, silky dogwood, Tatarian honeysuckle. | Eastern white pine, northern white-cedar, Austrian pine. | Norway spruce, red pine, laurel willow. | Carolina poplar. |
| Will: Wb | | Silky dogwood, American cranberry-bush. | Green ash, Amur maple. | Black spruce | Eastern cottonwood. |
| Winneconne: WnA, WnB, WnC2 | | Northern white-cedar, common ninebark, silky dogwood, lilac. | White spruce, Norway spruce. | Eastern white pine, red pine. | |
| Zittau: ZtA | Redosier dogwood, silky dogwood. | Northern white-cedar, American cranberry-bush, lilac. | White spruce, black spruce. | Eastern white pine, red pine. | Red maple, white ash, green ash. |

Table 4 shows the height that locally grown trees and shrubs are expected to reach on various kinds of soil in 20 years. The estimates in table 4, based on measurements and observation of established plantings that have been given adequate care, can be used as a guide in planning windbreaks and screens. Additional information about planning windbreaks and screens and the planting and care of trees can be obtained from local offices of the Soil Conservation Service or the

## Recreation

The soils of the survey area are rated in table 5 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area

TABLE 5.—*Recreational development*

["Percs slowly" and other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of

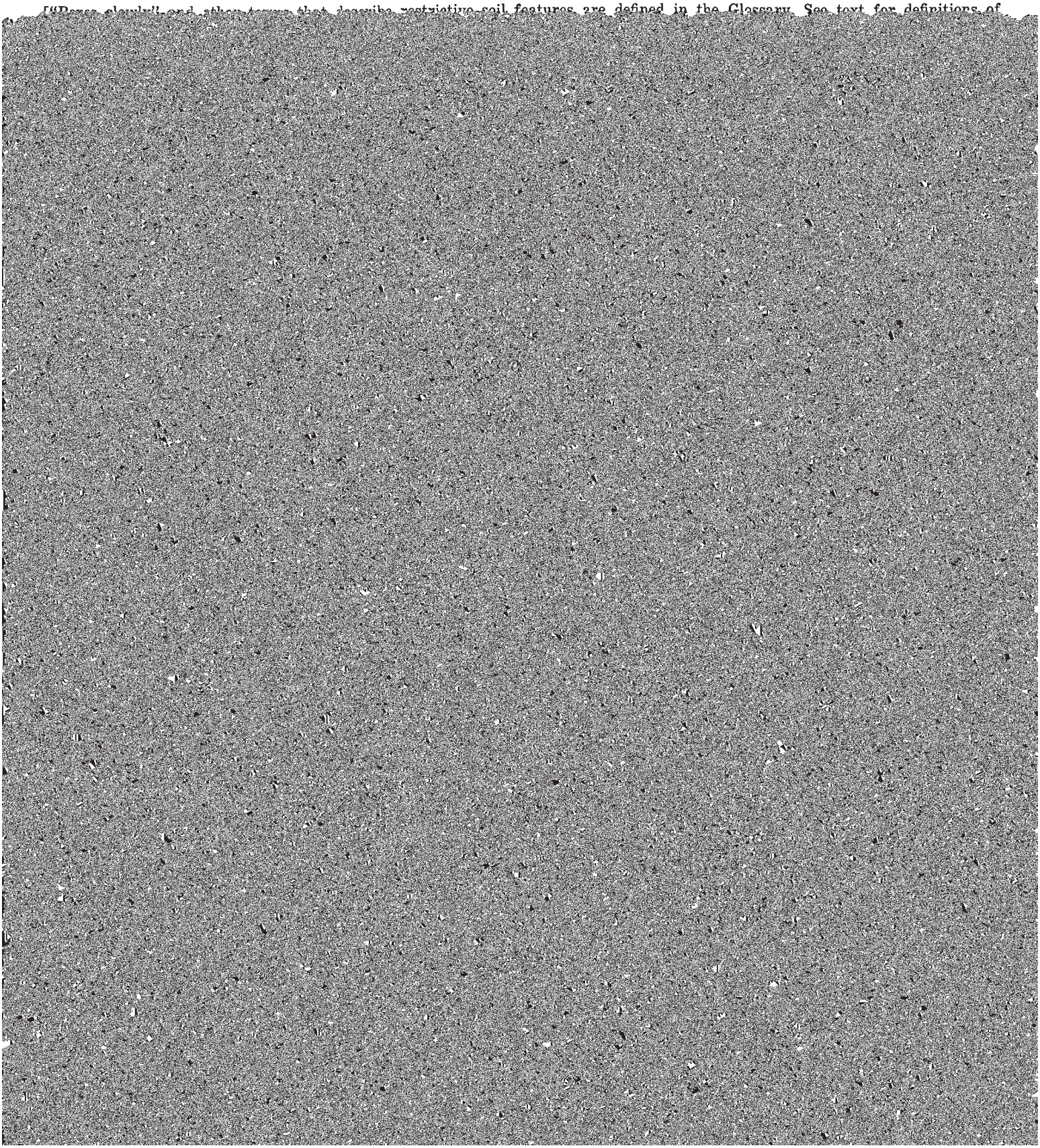


TABLE 5.—*Recreational development*—Continued

| Soil name and map symbol | Camp areas | Picnic areas | Playgrounds | Paths and trails |
|---|---|---|---|---|
| Hortonville: HnB, HrB, HsB, [1] HtB — For Symco part of [1]HtB, see Symco series. | Slight | Slight | Moderate: slope | Slight. |
| HnC2, HrC2, HsC2 | Moderate: slope | Moderate: slope | Severe: slope | Slight. |
| HrD2 | Severe: slope | Severe: slope | Severe: slope | Moderate: slope. |
| HrE | Severe: slope | Severe: slope | Severe: slope | Severe: slope. |
| Kaukauna: KaA | Moderate: percs slowly, too clayey. | Moderate: too clayey. | Moderate: percs slowly, too clayey. | Moderate: too clayey. |
| Keowns: Ke | Severe: wetness, floods. | Severe: wetness, floods. | Severe: wetness, floods. | Severe: wetness, floods. |
| Kewaunee: KhB, [1] KlB — [1]For Manawa part of KlB, see Manawa series. | Moderate: percs slowly. | Slight | Moderate: percs slowly. | Slight. |
| KhC2 | Moderate: percs slowly. | Moderate: slope | Severe: slope | Slight. |
| KhD2 | Severe: slope | Severe: slope | Severe: slope | Moderate: slope. |
| KkE3 | Severe: slope | Severe: slope | Severe: slope | Severe: slope. |
| Kolberg: KoB | Moderate: percs slowly. | Slight | Moderate: slope, depth to rock, percs slowly. | Slight. |
| KoC2 | Moderate: slope, percs slowly. | Moderate: slope | Severe: slope | Slight. |
| Limestone quarries: Ln. — Not rated. | | | | |
| Lobo: Lo | Severe: wetness | Severe: wetness | Severe: wetness | Severe: wetness. |
| Manawa: [1]McA | Severe: floods, wetness. | Moderate: floods, wetness. | Severe: floods, wetness. | Moderate: floods, wetness. |
| Manistee: MeB, MfB | Moderate: too sandy | Moderate: too sandy | Severe: too sandy | Moderate: too sandy. |
| MeC2 | Moderate: too sandy | Moderate: too sandy | Severe: too sandy, slope. | Moderate: too sandy. |
| Markey: Mk | Severe: wetness, floods, excess humus. | Severe: wetness, floods, excess humus. | Severe: wetness, floods, excess humus. | Severe: wetness, floods, excess humus. |
| Menominee: MsB | Moderate: too sandy | Moderate: too sandy | Severe: too sandy, soil blowing. | Moderate: too sandy. |
| MsC2 | Moderate: slope, too sandy. | Moderate: slope, too sandy. | Severe: slope, too sandy, soil blowing. | Moderate: too sandy. |
| Mosel: MtA | Moderate: wetness, percs slowly. | Moderate: wetness | Moderate: wetness, percs slowly. | Moderate: wetness. |
| Mundelein: MuA | Moderate: wetness | Moderate: wetness | Moderate: wetness | Moderate: wetness. |
| Namur: NaB | Slight | Slight | Severe: depth to rock. | Slight. |

See footnote at end of table.

TABLE 5.—*Recreational development*—Continued

| Soil name and map symbol | Camp areas | Picnic areas | Playgrounds | Paths and trails |
|---|---|---|---|---|
| Nichols: NfA, NsA | Slight | Slight | Slight | Slight. |

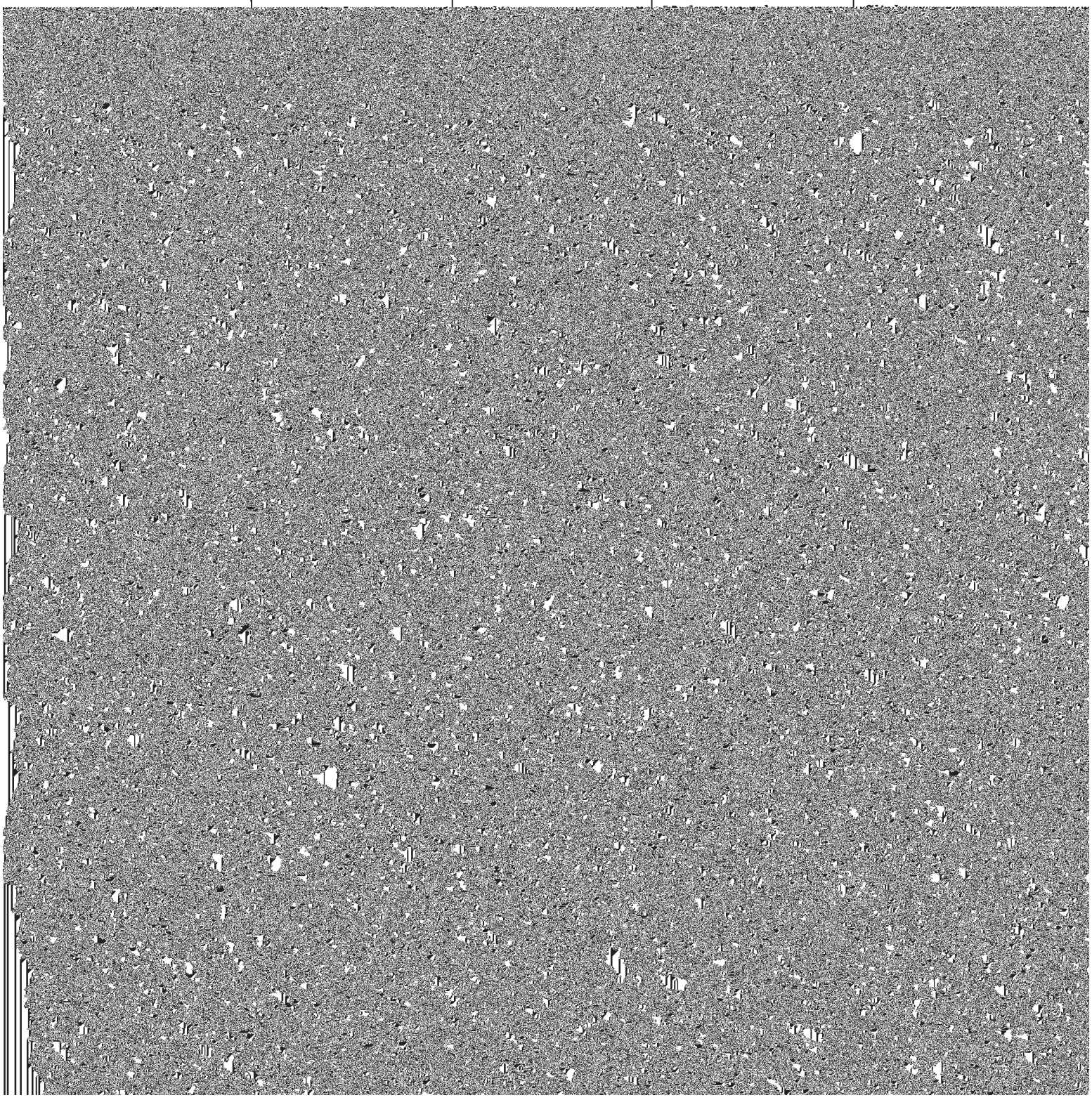


TABLE 5.—*Recreational development*—Continued

| Soil name and map symbol | Camp areas | Picnic areas | Playgrounds | Paths and trails |
|---|---|---|---|---|
| Zittau: ZtA ---------- | Moderate: wetness, percs slowly. | Moderate: wetness --- | Moderate: wetness, percs slowly. | Moderate: wetness. |

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and

*Figure 11.*—**Wooded swamp wetlands on Markey soils. Uprooted trees are evidence of severe windthrow hazard.**

rate wetlands inventory is not available, but the most textured and moderately coarse textured soils This

cover and feed for such wildlife species as white-tailed deer and pheasants.

Wildlife in this area are white-tailed deer, pheasants, waterfowl, cottontail rabbit, squirrel, ruffed grouse, and predators such as red fox and raccoon.

## Wildlife Habitat

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, is inadequate, or is inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

In table 6, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature

soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

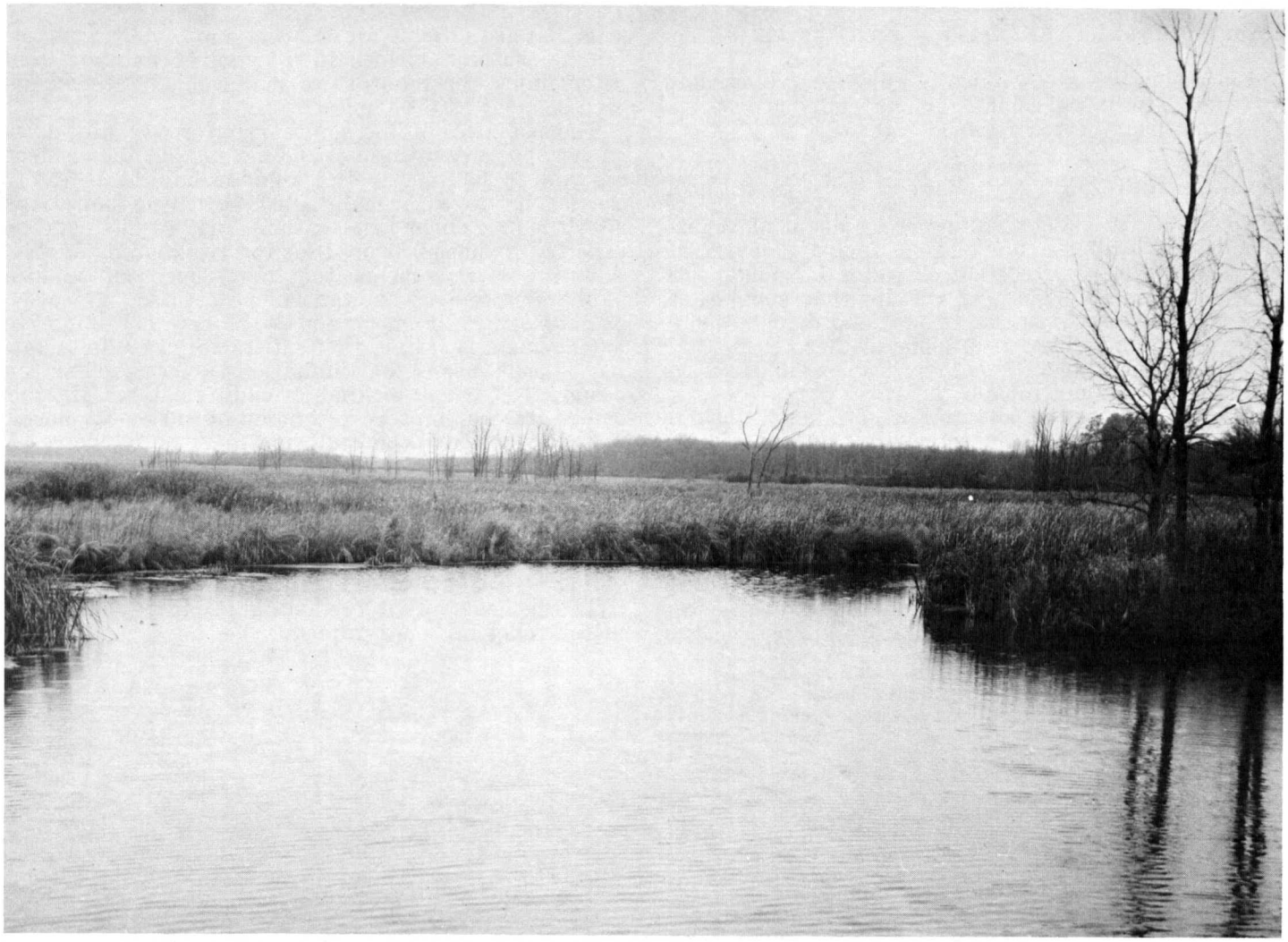


*Figure 13.*—**Wetlands of the Rat River Conservation Area on Carbondale soils provide good habitat for waterfowl and wetland animals.**

*Grain and seed crops* are seed-producing annuals used by wildlife. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

*Grasses and legumes* are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, lovegrass, bromegrass, clover, and alfalfa.

*Wild herbaceous plants* are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

*Hardwood trees* and the associated woody understory provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of native plants are oak, poplar, cherry, apple, hawthorn, dogwood, hickory, blackberry, and blueberry. Examples of fruit-producing shrubs that are commercially available and suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

*Coniferous plants* are cone-bearing trees, shrubs, or ground cover plants that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Soil properties that have a major effect on the growth of coniferous plants are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, cedar, and juniper.

*Wetland plants* are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, saltgrass, and cordgrass and rushes, sedges, and reeds.

*Shallow water areas* are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control structures in marshes or streams. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The kinds of wildlife habitat are briefly described in the following paragraphs.

*Openland wildlife* includes birds and mammals that use cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail rabbit, and red fox.

*Woodland wildlife* includes birds and mammals that use areas of hardwoods or conifers, or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

*Wetland wildlife* includes birds and mammals that use open, marshy or swampy, shallow water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

## Engineering[4]

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil Properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational uses; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

*Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.*

The information is presented mainly in tables. Table 7 shows, for each kind of soil, the degree and kind of limitations for building site development; table 8, for sanitary facilities; and table 10, for water management. Table 9 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a

[4] MICHAEL J. TIRY, civil engineer, Soil Conservation Service, Green Bay, helped prepare this section.

TABLE 6.—*Wildlife*

[See text for definitions of "good," "fair," "poor," and "very

| Soil name and map symbol | Potential for habitat elements | | | |
|---|---|---|---|---|
| | Grain and seed crops | Grasses and legumes | Wild herbaceous plants | Hardwood trees |
| Allendale: AdA | Fair | Fair | Good | Fair |
| Angelica: Ax | Good | Fair | Good | Good |
| Bellevue: Bc | Poor | Fair | Fair | Good |
| Bonduel: BnA | Fair | Good | Good | Good |
| Borth: BoA | Good | Good | Good | Good |
| Boyer: BrB, BrC2, BrD2 | Poor | Fair | Good | Good |
| Briggsville: BtA, BtB | Good | Good | Good | Good |
| Carbondale: Ca | Good | Fair | Good | Fair |
| Casco: | | | | |
| CcB, CcC2 | Fair | Fair | Fair | Fair |
| CcD2 | Poor | Fair | Fair | Fair |
| Cathro: Cm | Fair | Fair | Fair | Fair |
| Channahon: CnB | Poor | Poor | Fair | Fair |
| Deford: De | Fair | Fair | Good | Good |
| Eleva: ElB, ElC2 | Fair | Good | Good | Good |
| Fluvaquents: Fu | Poor | Poor | Fair | Fair |
| Gravel pits: Gp. | | | | |
| Grays: GrA, GrB | Good | Good | Good | Good |
| Hebron: HeB | Good | Good | Good | Good |
| Hortonville: HnB, HrB, HsB, HsC2, [1] HtB— For Symco part of HtB, see Symco series. | Good | Good | Good | Good |
| HnC2, HrC2 | Good | Good | Good | Good |
| HrD2 | Poor | Good | Good | Good |
| HrE | Very poor | Fair | Good | Good |
| Kaukauna: KaA | Good | Good | Good | Good |
| Keowns: Ke | Good | Good | Good | Fair |
| Kewaunee: KhB, [1] KlB — For Manawa part of KlB, see Manawa series. | Good | Good | Good | Good |
| KhC2 | Fair | Good | Good | Good |
| KhD2 | Poor | Fair | Good | Good |
| KkE3 | Very poor | Poor | Good | Good |
| Kolberg: KoB, KoC2 | Good | Good | Good | Good |
| Limestone quarries: Ln. | | | | |
| Lobo: Lo | Very poor | Very poor | Very poor | Very poor |

See footnote at end of table.

*habitat potentials*

poor." Absence of an entry indicates the soil was not rated]

| Potential for habitat elements—Continued | | | Potential as habitat for— | | |
|---|---|---|---|---|---|
| Coniferous plants | Wetland plants | Shallow water areas | Openland wildlife | Woodland wildlife | Wetland wildlife |
| Fair | Fair | Fair | Fair | Fair | Poor. |
| Fair | Good | Good | Good | Good | Good. |
| Good | Poor | Poor | Fair | Good | Very poor. |
| Good | Fair | Fair | Good | Good | Fair. |
| Good | Poor | Very poor | Good | Good | Very poor. |
| Good | Very poor | Very poor | Fair | Good | Very poor. |
| Good | Poor | Poor | Good | Good | Poor. |
| Good | Good | Good | Good | Good | Good. |
| Fair | Very poor | Very poor | Fair | Fair | Very poor. |
| Fair | Very poor | Very poor | Fair | Fair | Very poor. |
| Good | Good | Good | Fair | Good | Good. |
| Fair | Poor | Very poor | Poor | Fair | Very poor. |
| Fair | Good | Good | Fair | Good | Good. |
| Good | Very poor | Very poor | Good | Good | Very poor. |
| Fair | Good | Fair | Poor | Fair | Fair. |
| Good | Poor | Very poor | Good | Good | Very poor. |
| Good | Poor | Poor | Good | Good | Poor. |
| Good | Poor | Very poor | Good | Good | Very poor. |
| Good | Very poor | Very poor | Good | Good | Very poor. |
| Good | Very poor | Very poor | Fair | Good | Very poor. |
| Good | Very poor | Very poor | Fair | Good | Very poor. |
| Good | Poor | Poor | Good | Good | Poor. |
| Poor | Good | Good | Good | Fair | Good. |
| Good | Poor | Very poor | Good | Good | Very poor. |
| Good | Very poor | Very poor | Good | Good | Very poor. |
| Good | Very poor | Very poor | Fair | Good | Very poor. |
| Good | Very poor | Very poor | Poor | Good | Very poor. |
| Good | Very poor | Very poor | Good | Good | Very poor. |
| Very poor | Good | Good | Very poor | Very poor | Fair. |

TABLE 6.—*Wildlife habitat*

| Soil name and map symbol | Potential for habitat elements | | | |
|---|---|---|---|---|
| | Grain and seed crops | Grasses and legumes | Wild herbaceous plants | Hardwood trees |
| Manawa: McA | Good | Good | Good | Good |
| Manistee: | | | | |
| MeB | Poor | Fair | Good | Good |
| MeC2 | Poor | Fair | Good | Good |
| MfB | Good | Good | Good | Good |
| Markey: Mk | Fair | Fair | Good | Good |
| Menominee: MsB, MsC2 | Poor | Fair | Good | Fair |
| Mosel: MtA | Good | Good | Good | Good |
| Mundelein: MuA | Good | Good | Good | Good |
| Namur: NaB | Poor | Poor | Fair | Poor |
| Nichols: NfA, NfB, NsA, NsB | Good | Good | Good | Good |
| Nichols part of SnB | Good | Good | Good | Good |
| Onaway: | | | | |
| OhB, [1] OlB<br>For Solona part of OlB, see Solona series. | Good | Good | Good | Good |
| OhC2 | Fair | Good | Good | Good |
| OhD2 | Poor | Fair | Good | Good |
| Pella: Pe | Good | Good | Good | Good |
| Poy: Pf | Good | Good | Good | Good |
| Poygan: Po | Good | Good | Good | Good |
| Rock outcrop: Ra. | | | | |
| Rondeau: Rd | Fair | Fair | Fair | Fair |
| Rousseau: RoB | Poor | Poor | Good | Fair |
| Shawano: | | | | |
| SeC | Poor | Poor | Fair | Poor |
| SeD | Very poor | Very poor | Fair | Poor |
| Shiocton: ShA, SkA, [1] SnB<br>For Nichols part of SnB, see Nichols series. | Good | Good | Good | Good |
| Solona: | | | | |
| SoA | Good | Good | Good | Good |
| Solona part of OlB | Good | Good | Good | Good |
| Suamico: Su | Fair | Fair | Fair | Fair |
| Symco: SyA | Good | Good | Good | Good |
| Symco variant: SzA | Good | Good | Good | Good |
| Udifluvents: Uf | Fair | Good | Good | Good |
| Udorthents: Uo.<br>Not rated. | | | | |
| Wainola: WaA | Fair | Good | Good | Good |

See footnote at end of table.

*potentials*—Continued

| Potential for habitat elements—Continued | | | Potential as habitat for— | | |
|---|---|---|---|---|---|
| Coniferous plants | Wetland plants | Shallow water areas | Openland wildlife | Woodland wildlife | Wetland wildlife |
| Good | Good | Good | Good | Good | Good. |
| Good | Poor | Very poor | Fair | Good | Very poor. |
| Good | Very poor | Very poor | Fair | Good | Very poor. |
| Good | Poor | Very poor | Fair | Good | Very poor. |
| Good | Good | Good | Fair | Good | Good. |
| Fair | Very poor | Very poor | Fair | Fair | Very poor. |
| Good | Good | Good | Good | Good | Good. |
| Good | Good | Good | Good | Good | Good. |
| Poor | Very poor | Very poor | Poor | Fair | Very poor. |
| Good | Poor | Very poor | Good | Good | Very poor. |
| Good | Fair | Poor | Good | Good | Poor. |
| Good | Poor | Very poor | Good | Good | Very poor. |
| Good | Very poor | Very poor | Good | Good | Very poor. |

TABLE 6.—*Wildlife habitat*

| Soil name and map symbol | Potential for habitat elements | | | |
|---|---|---|---|---|
| | Grain and seed crops | Grasses and legumes | Wild herbaceous plants | Hardwood trees |
| Will: Wb | Good | Good | Good | Good |
| Wingcreek: WcA, WcB, WcC2 | Good | Good | Good | Good |

*potentials*—Continued

| Potential for habitat elements—Continued | | | Potential as habitat for— | | |
|---|---|---|---|---|---|
| Coniferous plants | Wetland plants | Shallow water areas | Openland wildlife | Woodland wildlife | Wetland wildlife |
| Fair | Fair | Fair | Good | Good | Fair. |
| Good | Poor | Poor | Good | Good | Poor. |
| Good | Good | Good | Good | Good | Good. |

behavior characteristics of the mapping unit.

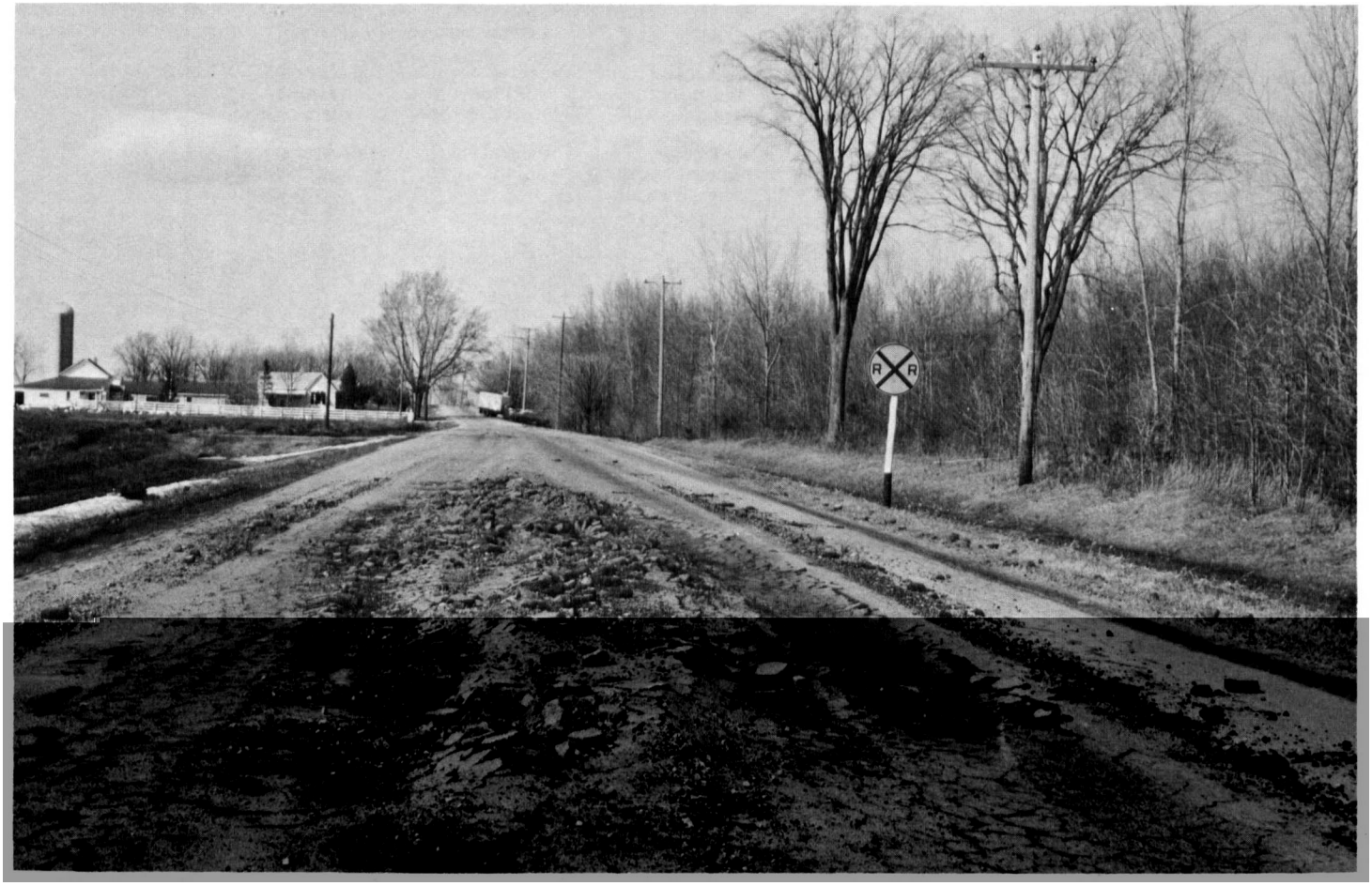


***Figure 14.*—Frost damage is severe on this road constructed on Keowns and Shiocton soils. Wet soils that have a high content of silt and very fine sand are particularly susceptible to frost action.**

about the same as the terms *slight, moderate,* and *severe.*

*Septic tank absorption fields* are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 60 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured

TABLE 7.—*Building site development*

["Shrink-swell" and other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

| Soil name and map symbol | Shallow excavations | Dwellings without basements | Dwellings with basements | Small commercial buildings | Local roads and streets |
|---|---|---|---|---|---|
| Allendale: AdA | Severe: wetness, cutbanks cave. | Severe: wetness, low strength. | Severe: wetness, shrink-swell, low strength. | Severe: wetness, low strength, shrink-swell. | Severe: low strength, shrink-swell. |
| Angelica: Ax | Severe: wetness, floods. | Severe: wetness, floods, frost action. | Severe: wetness, floods. | Severe: wetness, floods, frost action. | Severe: wetness, frost action, floods. |
| Bellevue: Bc | Severe: floods. | Severe: floods. | Severe: floods, wetness. | Severe: floods. | Severe: floods. |
| Bonduel: BnA | Severe: wetness. | Moderate: wetness, shrink-swell. | Severe: wetness, depth to rock. | Moderate: wetness, shrink-swell. | Severe: frost action. |
| Borth: BoA | Severe: too clayey, cutbanks cave. | Moderate: low strength, shrink-swell. | Moderate: shrink-swell. | Moderate: low strength, shrink-swell. | Severe: low strength. |
| Boyer: | | | | | |
| BrB | Severe: cutbanks cave. | Slight | Slight | Moderate: slope. | Slight. |
| BrC2 | Severe: cutbanks cave. | Moderate: slope. | Moderate: slope. | Severe: slope | Moderate: slope. |
| BrD2 | Severe: cutbanks cave. | Severe: slope | Severe: slope | Severe: slope | Severe: slope. |
| Briggsville: BtA, BtB | Slight | Severe: low strength. | Severe: low strength. | Severe: low strength. | Severe: low strength. |
| Carbondale: Ca | Severe: wetness, floods, excess humus. | Severe: wetness, floods, excess humus. | Severe: wetness, floods, excess humus. | Severe: wetness, floods, excess humus. | Severe: wetness, floods, excess humus. |
| Casco: | | | | | |
| CcB | Severe: cutbanks cave, small stones. | Slight | Slight | Moderate: slope. | Moderate: low strength. |
| CcC2 | Severe: cutbanks cave, small stones. | Moderate: slope. | Moderate: slope. | Severe: slope | Moderate: slope, low strength. |
| CcD2 | Severe: cutbanks cave, small stones. | Severe: slope | Severe: slope | Severe: slope | Severe: slope. |
| Cathro: Cm | Severe: wetness, floods, cutbanks cave. | Severe: wetness, floods, frost action. | Severe: wetness, floods. | Severe: wetness, floods. | Severe: wetness, low strength, frost action. |
| Channahon: CnB | Severe: depth to rock. | Severe: depth to rock. | Severe: depth to rock. | Severe: depth to rock. | Severe: depth to rock. |
| Deford: De | Severe: wetness, cutbanks cave, floods. | Severe: wetness, floods. | Severe: wetness, floods. | Severe: wetness, floods. | Severe: wetness, floods. |
| Eleva: | | | | | |
| ElB | Moderate: depth to rock. | Slight | Moderate: depth to rock. | Moderate: slope. | Moderate: low strength, frost action. |

TABLE 7.—*Building site development*—Continued

| Soil name and map symbol | Shallow excavations | Dwellings without basements | Dwellings with basements | Small commercial buildings | Local roads and streets |
|---|---|---|---|---|---|
| ElC2 | Moderate: slope. | Moderate: slope. | Moderate: slope. | Severe: slope | Moderate: slope, low strength, frost action. |
| Fluvaquents: Fu | Severe: floods, wetness. | Severe: floods, frost action, wetness. | Severe: floods, wetness. | Severe: floods, frost action, wetness. | Severe: floods, frost action, wetness. |
| Gravel pits: Gp. Not rated. | | | | | |
| Grays: GrA | Slight | Moderate: shrink-swell, low strength, frost action. | Slight | Moderate: shrink-swell, low strength. | Severe: frost action, low strength. |
| GrB | Slight | Moderate: shrink-swell, low strength, frost action. | Slight | Moderate: shrink-swell, low strength, slope. | Severe: frost action, low strength. |
| Hebron: HeB | Slight | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength. | Moderate: slope, shrink-swell, low strength. | Moderate: shrink-swell. |
| Hortonville: HnB, HrB, [1] HtB For Symco part of HtB, see Symco series. | Slight | Moderate: low strength, shrink-swell. | Moderate: low strength, shrink-swell. | Moderate: low strength, shrink-swell, slope. | Severe: low strength. |
| HnC2, HrC2 | Moderate: slope. | Moderate: low strength, shrink-swell, slope. | Moderate: low strength, shrink-swell, slope. | Severe: slope | Severe: low strength. |
| HrD2, HrE | Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: low strength, slope. |
| HsB | Moderate: too clayey. | Moderate: low strength, shrink-swell. | Moderate: low strength, shrink-swell. | Moderate: low strength, slope, shrink-swell. | Severe: low strength. |
| HsC2 | Moderate: too clayey, slope. | Moderate: low strength, slope, shrink-swell. | Moderate: low strength, slope, shrink-swell. | Severe: slope | Severe: low strength. |
| Kaukauna: KaA | Severe: too clayey. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. |
| Keowns: Ke | Severe: wetness, floods. | Severe: wetness, floods, frost action. | Severe: wetness, floods, frost action. | Severe: wetness, floods, frost action. | Severe: wetness, floods, frost action. |
| Kewaunee: KhB, [1] KlB For Manawa part of KlB, see Manawa series. | Severe: too clayey. | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength, slope. | Severe: low strength. |

See footnote at end of table.

TABLE 7.—*Building site development*—Continued

| Soil name and map symbol | Shallow excavations | Dwellings without basements | Dwellings with basements | Small commercial buildings | Local roads and streets |
|---|---|---|---|---|---|
| KhC2 | Severe: too clayey. | Moderate: shrink-swell, low strength, slope. | Moderate: shrink-swell, low strength, slope. | Severe: slope | Severe: low strength. |
| KhD2, KkE3 | Severe: slope, too clayey. | Severe: slope | Severe: slope | Severe: slope | Severe: low strength, slope. |
| Kolberg: | | | | | |
| KoB | Severe: too | Moderate: | Moderate: | Moderate: | Severe: |

TABLE 7.—*Building site development*—Continued

| Soil name and map symbol | Shallow excavations | Dwellings without basements | Dwellings with basements | Small commercial buildings | Local roads and streets |
|---|---|---|---|---|---|
| NfB | Slight | Slight | Slight | Moderate: slope. | Severe: frost action. |
| NsA | Severe: too clayey. | Moderate: low strength, frost action. | Severe: low strength. | Moderate: low strength, frost action. | Moderate: low strength. |
| NsB | Severe: too clayey. | Moderate: low strength, frost action. | Severe: low strength. | Moderate: low strength, slope, frost action. | Moderate: low strength. |
| Onaway: | | | | | |
| OhB, [1] OlB<br>For Solona part of OlB, see Solona series. | Slight | Moderate: frost action. | Slight | Moderate: slope, frost action. | Moderate: frost action, shrink-swell. |
| OhC2 | Moderate: slope. | Moderate: frost action, slope. | Moderate: slope. | Severe: slope | Moderate: slope, frost action, shrink-swell. |
| OhD2 | Severe: slope | Severe: slope | Severe: slope | Severe: slope | Severe: slope. |
| Pella: Pe | Severe: wetness, floods. | Severe: wetness, floods. | Severe: wetness, floods. | Severe: wetness, floods. | Severe: wetness, floods, frost action. |
| Poy: Pf | Severe: floods, wetness, cutbanks cave. | Severe: wetness, floods, low strength. | Severe: wetness, floods. | Severe: wetness, floods, low strength. | Severe: wetness, frost action, low strength. |
| Poygan: Po | Severe: wetness, floods, too clayey. | Severe: wetness, floods, low strength. | Severe: wetness, floods, low strength. | Severe: wetness, floods, low strength. | Severe: wetness, floods, low strength. |
| Rock outcrop: Ra.<br>Not rated. | | | | | |
| Rondeau: Rd | Severe: wetness, excess humus. | Severe: floods, frost action, low strength. | Severe: floods, low strength, wetness. | Severe: floods, low strength, wetness. | Severe: frost action, low strength, wetness. |
| Rousseau: RoB | Severe: cutbanks cave. | Slight | Slight | Moderate: slope. | Slight. |
| Shawano: | | | | | |
| SeC | Severe: cutbanks cave. | Moderate: slope. | Moderate: slope. | Severe: slope | Moderate: slope. |
| SeD | Severe: cutbanks cave, slope. | Severe: slope | Severe: slope | Severe: slope | Severe: slope. |
| Shiocton: ShA, SkA, [1] SnB<br>For Nichols part of SnB, see NfB in Nichols series. | Severe: wetness, floods. | Severe: frost action, wetness, floods. | Severe: wetness, floods. | Severe: frost action, wetness, floods. | Severe: frost action, floods. |
| Solona: SoA | Severe: wetness, floods. | Severe: floods, wetness, frost action. | Severe: wetness, floods, frost action. | Severe: floods, wetness, frost action. | Severe: frost action, floods. |
| Suamico: Su | Severe: wetness, floods. | Severe: wetness, floods, low strength. | Severe: wetness, floods, low strength. | Severe: wetness, floods, low strength. | Severe: wetness, floods, low strength. |

See footnote at end of table.

TABLE 7.—*Building site development*—Continued

| Soil name and map symbol | Shallow excavations | Dwellings without basements | Dwellings with basements | Small commercial buildings | Local roads and streets |
|---|---|---|---|---|---|
| Symco: SyA | Severe: wetness. | Moderate: shrink-swell, low strength. | Severe: wetness. | Moderate: shrink-swell, low strength. | Severe: frost action, low strength. |
| Symco variant: SzA | Severe: wetness, cutbanks cave, floods. | Severe: floods, wetness, frost action. | Severe: wetness, floods. | Severe: floods, wetness, frost action. | Severe: frost action, floods. |
| Udifluvents: Uf | Severe: floods. | Severe: floods. | Severe: floods. | Severe: floods. | Severe: floods, frost action. |
| Udorthents: Uo | Moderate: too clayey. | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength. | Moderate: shrink-swell, low strength, frost action. |
| Wainola: WaA | Severe: wetness, cutbanks cave. | Severe: wetness. | Severe: wetness. | Severe: wetness. | Moderate: wetness, frost action. |
| Will: Wb | Severe: wetness, floods. | Severe: wetness, floods. | Severe: wetness, floods. | Severe: wetness, floods. | Severe: wetness, frost action. |
| Winneconne: WnA, WnB | Severe: too clayey. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. |
| WnC2 | Severe: too clayey. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength. | Severe: shrink-swell, low strength, slope. | Severe: shrink-swell, low strength. |
| Zittau: ZtA | Severe: wetness, too clayey, cutbanks cave. | Severe: wetness, floods. | Severe: wetness, floods. | Severe: wetness, floods. | Severe: wetness, frost action. |

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior characteristics of the mapping unit.

bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

*Sewage lagoons* are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

*Sanitary landfill* is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding.

TABLE 8.—*Sanitary facilities*

["Percs slowly" and other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate soils]

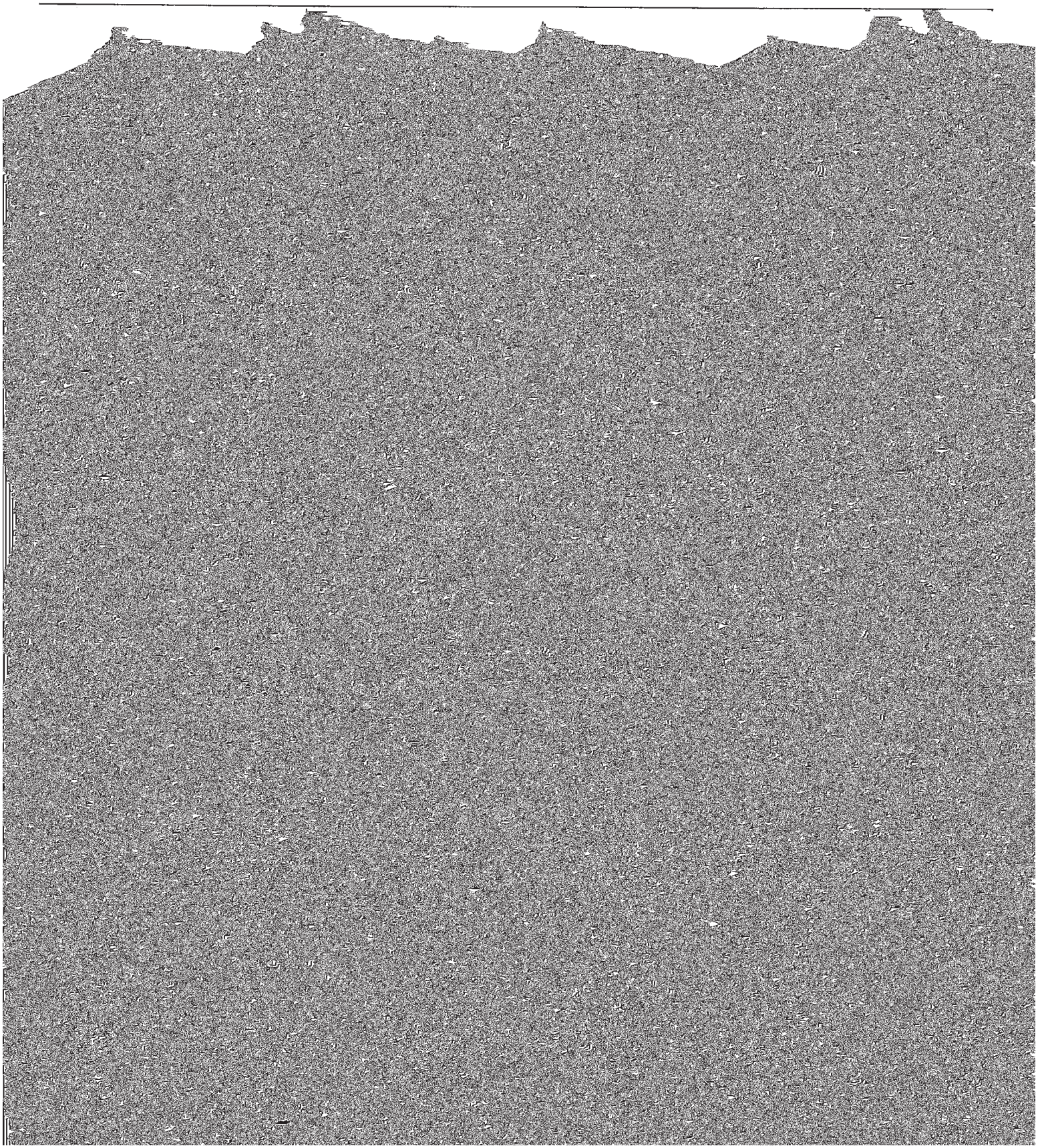


TABLE 8.—*Sanitary facilities*—Continued

| Soil name and map symbol | Septic tank absorption fields | Sewage lagoons | Trench sanitary landfill | Area sanitary landfill | Daily cover for landfill |
|---|---|---|---|---|---|
| EIC2 | Moderate: slope | Severe: slope | Severe: depth to rock | Severe: slope | Poor: thin layer |

TABLE 8.—*Sanitary facilities*—Continued

| Soil name and map symbol | Septic tank absorption fields | Sewage lagoons | Trench sanitary landfill | Area sanitary landfill | Daily cover for landfill |
|---|---|---|---|---|---|
| KoC2 | Severe: depth to rock, percs slowly. | Severe: depth to rock, slope. | Severe: depth to rock, too clayey. | Moderate: slope. | Poor: thin layer, area reclaim. |
| Limestone quarries: Ln. Not rated. | | | | | |
| Lobo: Lo | Severe: wetness. | Severe: excess humus, wetness. | Severe: wetness, excess humus. | Severe: wetness. | Poor: wetness, excess humus. |
| Manawa: McA | Severe: wetness, percs slowly, floods. | Moderate: slope. | Severe: wetness, too clayey, floods. | Severe: wetness, floods. | Poor: too clayey. |
| Manistee: MeB, MfB | Severe: percs slowly. | Moderate: slope. | Severe: too clayey. | Slight | Poor: too sandy. |
| MeC2 | Severe: percs slowly. | Severe: slope | Severe: too clayey. | Moderate: slope. | Poor: too sandy. |
| Markey: Mk | Severe: wetness, floods. | Severe: wetness, excess humus, seepage. | Severe: wetness, floods, seepage. | Severe: wetness, floods, seepage. | Poor: excess humus, hard to pack. |
| Menominee: MsB | Slight | Moderate: slope, seepage. | Slight | Slight | Poor: too sandy. |
| MsC2 | Moderate: slope. | Severe: slope | Slight | Moderate: slope. | Poor: too sandy. |
| Mosel: MtA | Severe: wetness, percs slowly. | Severe: wetness. | Severe: wetness. | Moderate: wetness, floods. | Fair: thin layer. |
| Mundelein: MuA | Severe: wetness. | Severe: wetness. | Severe: wetness. | Moderate: wetness. | Fair: too clayey. |
| Namur: NaB | Severe: depth to rock. | Severe: depth to rock. | Severe: depth to rock. | Severe: seepage. | Poor: thin layer, small stones, area reclaim. |
| Nichols: NfA, NfB | Slight | Moderate: seepage. | Slight | Slight | Good. |
| NsA | Severe: percs slowly. | Slight | Severe: too clayey. | Slight | Good. |
| NsB | Severe: percs slowly. | Moderate: slope. | Severe: too clayey. | Slight | Good. |
| Onaway: OhB, [1]O1B | Severe: percs slowly. | Moderate: slope. | Slight | Slight | Good. |
| For Solona part of O1B, see Solona series. | | | | | |
| OhC2 | Severe: percs slowly. | Severe: slope | Slight | Moderate: slope. | Fair: slope. |

TABLE 8.—*Sanitary facilities*—Continued

| Soil name and map symbol | Septic tank absorption fields | Sewage lagoons | Trench sanitary landfill | Area sanitary landfill | Daily cover for landfill |
|---|---|---|---|---|---|
| Poy: Pf | Severe: wetness, floods, percs slowly. | Severe: wetness, seepage. | Severe: wetness, floods, seepage. | Severe: wetness, floods. | Poor: wetness, thin layer. |
| Poygan: Po | Severe: wetness, percs slowly, floods. | Severe: floods. | Severe: wetness, floods, too clayey. | Severe: wetness, floods. | Poor: wetness, too clayey. |
| Rock outcrop: Ro. Not rated. | | | | | |
| Rondeau: Rd | Severe: wetness, floods. | Severe: floods, seepage, wetness. | Severe: wetness, floods, excess humus. | Severe: wetness, floods. | Poor: excess humus, wetness. |
| Rousseau: RoB | Slight | Severe: seepage. | Severe: seepage. | Severe: seepage. | Poor: too sandy. |
| Shawano: SeC | Moderate: slope. | Severe: seepage, slope. | Severe: seepage. | Severe: seepage. | Poor: too sandy, seepage. |
| SeD | Severe: slope | Severe: seepage, slope. | Severe: seepage. | Severe: seepage, slope. | Poor: too sandy, seepage, slope. |
| Shiocton: ShA, [1] SnB | Severe: wetness, floods. | Severe: wetness, floods. | Severe: wetness, floods. | Severe: floods, wetness. | Good. |
| For Nichols part of SnB, see NfB in Nichols series. | | | | | |
| SkA | Severe: wetness, floods. | Slight | Severe: wetness, floods. | Severe: wetness, floods. | Good. |
| Solona: SoA | Severe: wetness, floods. | Severe: wetness, floods. | Severe: floods, wetness. | Severe: floods, wetness. | Good. |
| Suamico: Su | Severe: wetness, floods. | Severe: wetness, floods. | Severe: wetness, floods. | Severe: wetness, floods. | Poor: wetness, excess humus. |
| Symco: SyA | Severe: wetness, percs slowly. | Severe: wetness. | Severe: wetness. | Moderate: wetness. | Fair: thin layer. |
| Symco variant: SzA | Severe: wetness, floods. | Severe: wetness, seepage. | Severe: seepage, wetness, floods. | Severe: seepage, wetness, floods. | Fair: thin layer, area reclaim. |
| Udifluvents: Uf | Severe: floods. | Severe: floods. | Severe: floods. | Severe: floods. | Good. |
| Udorthents: Uo | Severe: percs slowly. | Moderate: slope. | Severe: too clayey. | Slight | Fair: too clayey. |
| Wainola: WaA | Severe: wetness. | Severe: wetness, seepage. | Severe: wetness, seepage. | Severe: wetness, seepage. | Poor: seepage, too sandy. |
| Will: Wb | Severe: wetness, floods. | Severe: wetness, seepage. | Severe: wetness, floods, seepage. | Severe: wetness, floods. | Poor: wetness, area reclaim. |
| Winneconne: WnA | Severe: percs slowly. | Slight | Severe: too clayey. | Slight | Poor: too clayey. |
| WnB | Severe: percs slowly. | Moderate: slope. | Severe: too clayey. | Slight | Poor: too clayey. |

See footnote at end of table.

TABLE 8.—*Sanitary facilities*—Continued

| Soil name and map symbol | Septic tank absorption fields | Sewage lagoons | Trench sanitary landfill | Area sanitary landfill | Daily cover for landfill |
|---|---|---|---|---|---|
| WnC2 | Severe: percs slowly. | Severe: slope | Severe: too clayey. | Slight | Poor: too clayey. |
| Zittau: ZtA | Severe: wetness, percs slowly. | Severe: wetness, seepage. | Severe: wetness, seepage. | Severe: wetness, seepage. | Poor: thin layer, too clayey. |

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior characteristics of the mapping unit.

Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 8 apply only to the soil material within a depth of about 5 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

*Daily cover for landfill* should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

### *Construction materials*

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 9 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 5 feet.

*Roadfill* is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 11 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*.

*Sand* and *gravel* are used in great quantities in many kinds of construction. The ratings in table 9 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizeable quantities of sand or gravel (fig. 15). A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 11.

*Topsoil* is used in areas where vegetation is to be established and maintained. Suitability is affected

TABLE 9.—*Construction materials*

["Shrink-swell" and other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor"]

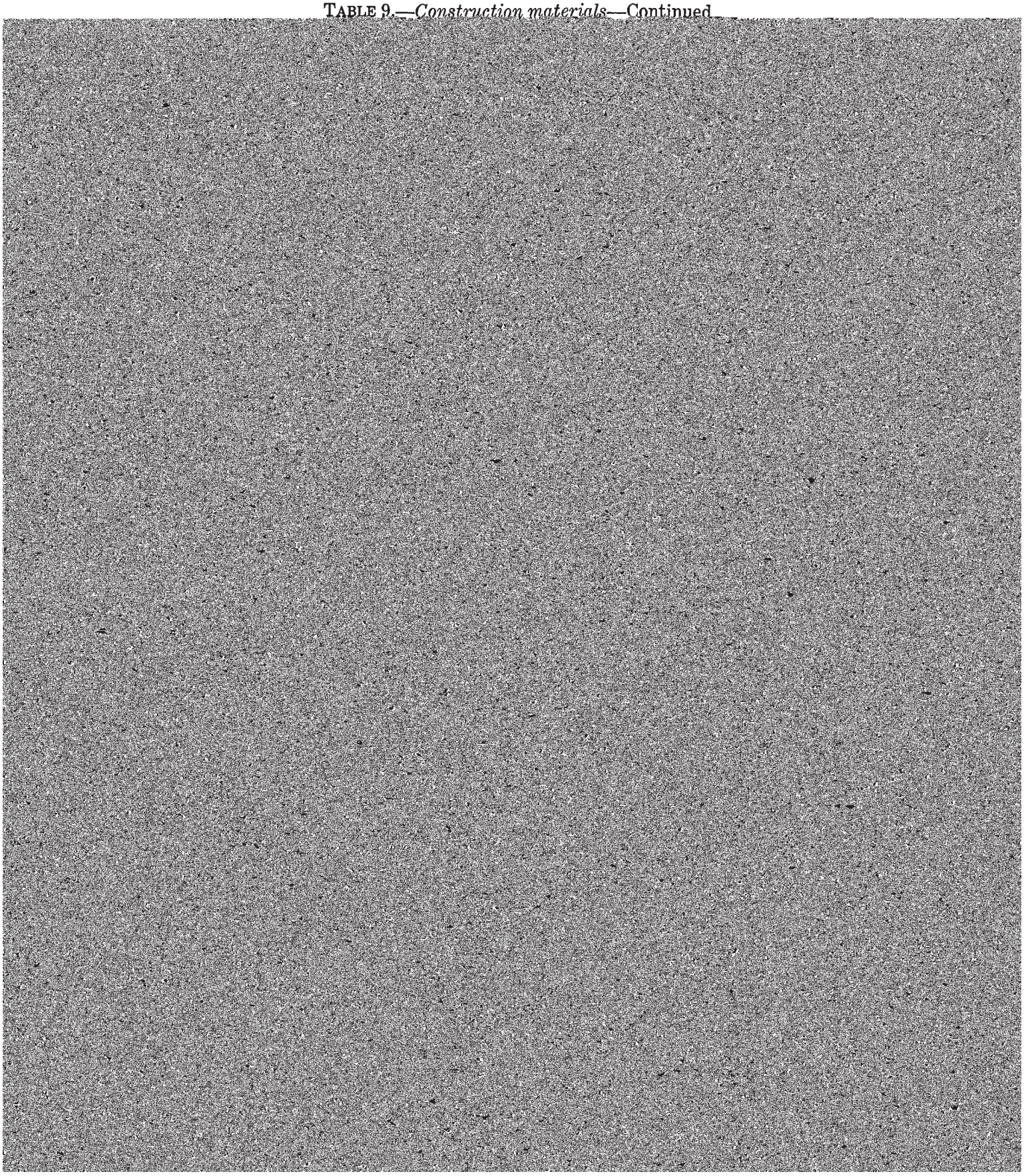
| Soil name and map symbol | Roadfill | Sand | Gravel | Topsoil |
|---|---|---|---|---|
| Allendale: AdA | Poor: low strength, shrink-swell. | Poor: thin layer | Unsuited | Poor: too sandy. |
| Angelica: Ax | Poor: wetness, frost action. | Unsuited | Unsuited | Poor: wetness. |
| Bellevue: Bc | Fair: frost action, low strength. | Unsuited | Unsuited | Good. |
| Pondnol: BnA | Poor: frost action | Unsuited | Unsuited | Fair: thin layer |

TABLE 9.—*Construction materials*—Continued

| Soil name and map symbol | Roadfill | Sand | Gravel | Topsoil |
|---|---|---|---|---|
| HrE | Poor: low strength, shrink-swell, slope. | Unsuited | Unsuited | Poor: slope. |
| HsB | Poor: low strength | Unsuited | Unsuited | Fair: thin layer. |
| HsC2 | Poor: low strength | Unsuited | Unsuited | Fair: thin layer, slope. |
| Kaukauna: KaA | Poor: low strength, shrink-swell. | Unsuited | Unsuited | Fair: thin layer, too clayey. |
| Keowns: Ke | Poor: wetness, frost action. | Unsuited | Unsuited | Poor: wetness. |
| Kewaunee: KhB, [1] KlB | Poor: low strength | Unsuited | Unsuited | Fair: thin layer. |
| For Manawa part of KlB, see Manawa series. | | | | |
| KhC2 | Poor: low strength | Unsuited | Unsuited | Fair: thin layer, slope. |
| KhD2 | Poor: low strength | Unsuited | Unsuited | Poor: slope. |
| KkE3 | Poor: low strength, slope. | Unsuited | Unsuited | Poor: slope. |
| Kolberg: KoB | Poor: low strength, area reclaim. | Unsuited | Unsuited | Fair: thin layer. |
| KoC2 | Poor: low strength, area reclaim. | Unsuited | Unsuited | Fair: thin layer, slope. |
| Limestone quarries: Ln. Not rated. | | | | |
| Lobo: Lo | Poor: wetness, excess humus, low strength. | Unsuited | Unsuited | Poor: wetness. |
| Manawa: McA | Poor: low strength | Unsuited | Unsuited | Fair: too clayey. |
| Manistee: MeB, MeC2 | Fair: thin layer, area reclaim. | Poor: excess fines | Unsuited | Poor: too sandy. |
| MfB | Fair: thin layer, area reclaim. | Poor: excess fines | Unsuited | Poor: area reclaim. |
| Markey: Mk | Poor: excess humus, wetness. | Poor: excess fines | Unsuited | Poor: wetness. |
| Menominee: MsB, MsC2 | Fair: frost action, low strength. | Unsuited: thin layer | Unsuited | Poor: too sandy. |
| Mosel: MtA | Poor: frost action, low strength. | Unsuited | Unsuited | Good. |
| Mundelein: MuA | Poor: frost action, low strength. | Unsuited | Unsuited | Fair: thin layer. |
| Namur: NaB | Poor: thin layer, area reclaim. | Unsuited | Unsuited | Poor: thin layer, area reclaim. |
| Nichols: NfA, NfB | Poor: frost action | Poor: excess fines | Unsuited | Good. |
| NsA, NsB | Poor: low strength | Unsuited | Unsuited | Good. |

See footnote at end of table.

TABLE 9.—*Construction materials*—Continued



mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness [illegible]

quality of the water, and ease of excavation.

*Drainage* of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks;

TABLE 10.—*Water management*

["Seepage" and other terms that describe restrictive soil features are defined in the Glossary]

| Soil name and map symbol | Pond reservoir areas | Embankments, dikes, and levees | Aquifer-fed excavated ponds | Drainage | Terraces and diversions | Grassed waterways |
|---|---|---|---|---|---|---|
| Allendale: AdA | Seepage | Thin layer | Slow refill | Cutbanks cave | Not needed | Not needed. |
| Angelica: Ax | Favorable | Piping, low strength. | Favorable | Poor outlets, floods. | Not needed | Wetness. |
| Bellevue: Bc | Seepage | Low strength, piping. | Deep to water | Floods | Erodes easily | Erodes easily. |
| Bonduel: BnA | Depth to rock, seepage. | Low strength, piping, thin layer. | Deep to water | Depth to rock, frost action, wetness. | Wetness, depth to rock. | Wetness, rooting depth. |
| Borth: BoA | Seepage | Compressible, shrink-swell, low strength. | Deep to water | Not needed | Percs slowly | Percs slowly. |
| Boyer: BrB, BrC2, BrD2 | Seepage, slope | Seepage | No water | Not needed | Complex slope, soil blowing. | Slope. |
| Briggsville: BtA, BtB | Favorable | Shrink-swell, low strength. | Deep to water | Not needed | Percs slowly | Percs slowly. |
| Carbondale: Ca | Seepage | Excess humus | Favorable | Floods, wetness, cutbanks cave. | Not needed | Not needed. |
| Casco: CcB, CcC2, CcD2 | Seepage | Seepage | No water | Not needed | Rooting depth | Droughty, rooting depth. |
| Cathro: Cm | Seepage | Compressible, hard to pack, low strength. | Favorable | Wetness, floods, cutbanks cave. | Not needed | Not needed. |
| Channahon: CnB | Depth to rock | Thin layer | No water | Not needed | Depth to rock | Rooting depth. |
| Deford: De | Seepage | Piping, seepage. | Favorable | Cutbanks cave | Not needed | Not needed. |
| Eleva: ElB, ElC2 | Depth to rock, seepage. | Piping, thin layer. | No water | Not needed | Depth to rock, slope. | Droughty, rooting depth, slope. |
| Fluvaquents: Fu | Seepage | Low strength, piping, seepage. | Favorable | Floods, wetness. | Not needed | Wetness. |
| Gravel pits: Gp. Not rated. | | | | | | |
| Grays: GrA | Seepage | Low strength, piping. | Deep to water | Not needed | Favorable | Favorable. |
| GrB | Seepage | Low strength, piping. | Deep to water | Not needed | Favorable | Slope, erodes easily. |
| Hebron: HeB | Favorable | Shrink-swell, low strength. | No water | Not needed | Percs slowly | Percs slowly. |
| Hortonville: HnB, HnC2, HrB, HrC2, HrD2, HrE, HsB, HsC2, [1] HtB. For Symco part of HtB, see Symco series. | Seepage, slope | Low strength, shrink-swell. | No water | Not needed | Complex slope, percs slowly. | Percs slowly, slope. |
| Kaukauna: KaA | Favorable | Low strength, shrink-swell. | Deep to water | Not needed | Erodes easily, percs slowly. | Erodes easily, percs slowly. |
| Keowns: Ke | Seepage | Low strength, piping. | Deep to water | Wetness, floods, frost action. | Wetness, piping. | Wetness. |

See footnote at end of table.

TABLE 10.—*Water management*—Continued

| Soil name and map symbol | Pond reservoir areas | Embankments, dikes, and levees | Aquifer-fed excavated ponds | Drainage | Terraces and diversions | Grassed waterways |
|---|---|---|---|---|---|---|
| Kewaunee: KhB, KhC2, KhD2, KkE3, [1] KlB. For Manawa part of KlB, see Manawa series. | Favorable | Shrink-swell, low strength. | No water | Not needed | Erodes easily, percs slowly. | Erodes easily, percs slowly |
| Kolberg: KoB, KoC2 | Depth to rock, seepage. | Low strength, thin layer, shrink-swell. | No water | Not needed | Depth to rock, erodes easily, percs slowly. | Erodes easily, percs slowly, rooting depth. |
| Limestone quarries: Ln. Not rated. | | | | | | |
| Lobo: Lo | Seepage | Compressible, seepage, low strength. | Favorable | Favorable | Not needed | Not needed. |
| Manawa: McA | Favorable | Shrink-swell, low strength. | Deep to water | Percs slowly, floods. | Wetness, percs slowly, rooting depth. | Wetness, percs slowly, rooting depth. |
| Manistee: MeB, MfB | Favorable | Unstable fill, seepage. | No water | Not needed | Soil blowing, complex slope. | Droughty, soil blowing. |
| MeC2 | Slope | Unstable fill, seepage. | No water | Not needed | Soil blowing, complex slope. | Droughty, soil blowing. |
| Markey: Mk | Seepage | Compressible, seepage, hard to pack. | Favorable | Floods, wetness, cutbanks cave. | Not needed | Not needed. |
| Menominee: MsB, MsC2 | Seepage, slope | Low strength, piping, shrink-swell. | No water | Not needed | Too sandy, soil blowing, droughty. | Slope, droughty. |
| Mosel: MtA | Favorable | Low strength, piping, shrink-swell. | Deep to water | Percs slowly, frost action. | Wetness, percs slowly, piping. | Wetness. |
| Mundelein: MuA | Seepage | Low strength, piping. | Slow refill | Favorable | Not needed | Favorable. |
| Namur: NaB | Depth to rock | Thin layer | No water | Not needed | Depth to rock | Droughty. |

TABLE 10.—*Water management*—Continued

| Soil name and map symbol | Pond reservoir areas | Embankments, dikes, and levees | Aquifer-fed excavated ponds | Drainage | Terraces and diversions | Grassed waterways |
|---|---|---|---|---|---|---|
| Rock outcrop: Ra. Not rated. | | | | | | |
| Rondeau: Rd | Seepage | Compressible, seepage, low strength. | Favorable | Floods, cutbanks cave, wetness. | Not needed | Not needed. |
| Rousseau: RoB | Seepage | Seepage, piping. | No water | Not needed | Too sandy, soil blowing. | Droughty. |
| Shawano: SeC, SeD | Seepage | Seepage, piping, erodes easily. | No water | Not needed | Complex slope, too sandy, soil blowing. | Droughty, erodes easily, slope. |
| Shiocton: ShA, [1] SnB For Nichols part of SnB, see NfB in Nichols series. | Seepage | Low strength, piping, hard to pack. | Deep to water | Floods, wetness. | Piping, wetness, erodes easily. | Erodes easily, wetness. |
| SkA | Seepage | Low strength, piping. | Deep to water | Wetness, floods. | Wetness, erodes easily. | Wetness, erodes easily. |
| Solona: SoA | Seepage | Low strength, piping. | Deep to water | Floods, wetness. | Wetness | Wetness. |
| Suamico: Su | Favorable | Excess humus, seepage, low strength. | Favorable | Percs slowly, wetness, floods. | Wetness, percs slowly. | Wetness, percs slowly. |
| Symco: SyA | Favorable | Low strength, compressible. | Favorable | Percs slowly | Not needed | Not needed. |
| Symco variant: SzA | Seepage | Low strength | Favorable | Wetness, cutbanks cave. | Wetness | Wetness. |
| Udifluvents: Uf | Seepage | Low strength, piping. seepage. | Deep to water | Floods, frost action. | Not needed | Favorable. |
| Udorthents: Uo | Favorable | Low strength, shrink-swell. | No water | Not needed | Percs slowly | Percs slowly. |
| Wainola: WaA | Seepage | Piping, seepage. | Deep to water | Cutbanks cave | Not needed | Not needed. |
| Will: Wb | Favorable | Seepage | Favorable | Favorable | Not needed | Not needed. |
| Winneconne: WnA, WnB WnC2. | Favorable | Low strength, shrink-swell. | Deep to water | Percs slowly | Percs slowly | Percs slowly. |
| Zittau: ZtA | Seepage | Low strength | Favorable | Percs slowly | Not needed | Not needed. |

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior characteristics of the mapping unit.

## *Soil Properties*

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially

all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features, engineering test data, and data obtained from physical and chemical laboratory analyses of soils.

## Engineering Properties

Table 11 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 11 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Descriptions of the Soils."

*Texture* is described in table 11 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifiying soils for engineering use are the Unified Soil Classification System (Unified) (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*1*).

The *Unified* system classifies soils according to properties that affect their use for engineering construction and A–7–6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested in the survey area, with group index numbers in parentheses, is given in table 14. The estimated classification, without group index numbers, is given in table 11. Also in table 11 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

*Liquid limit* and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterburg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

## Physical and Chemical Properties

Table 12 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given

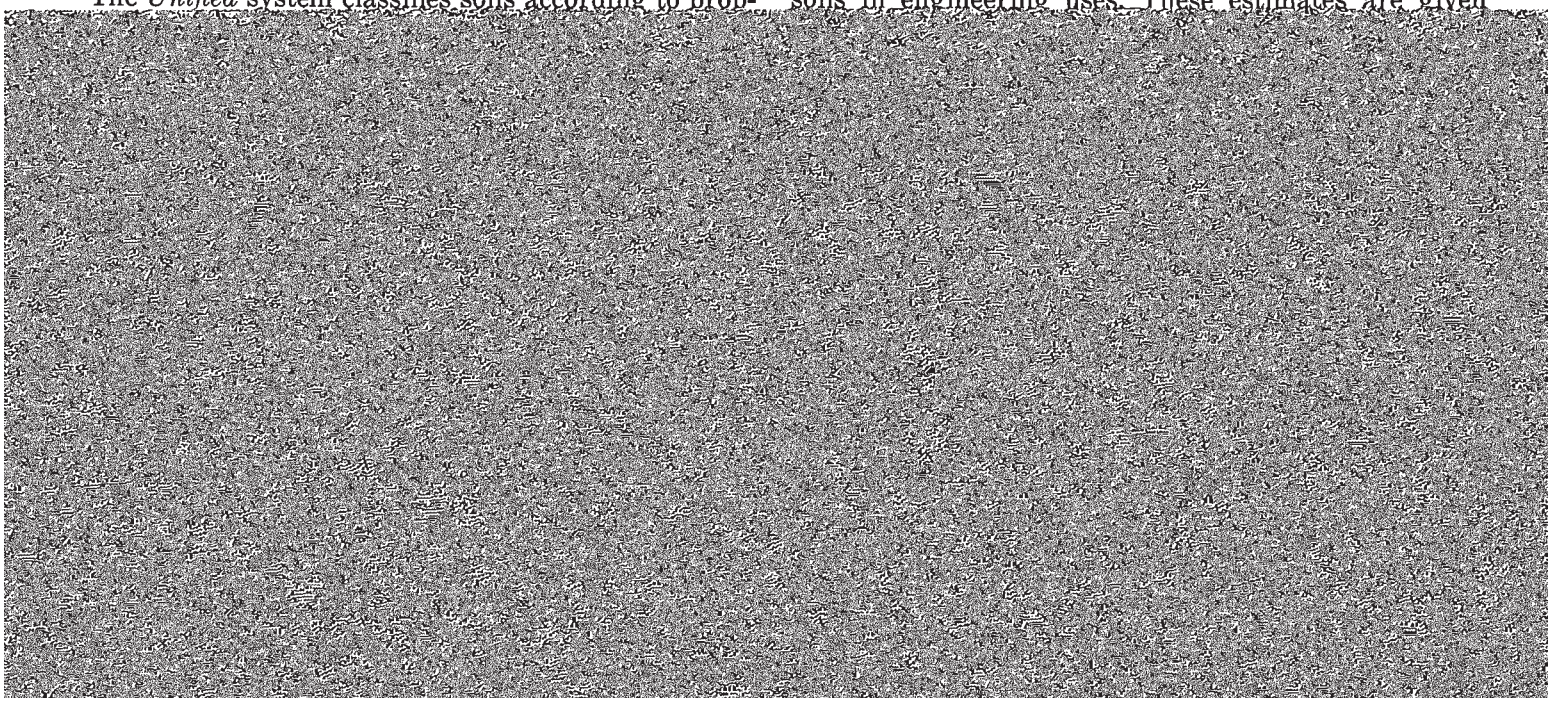
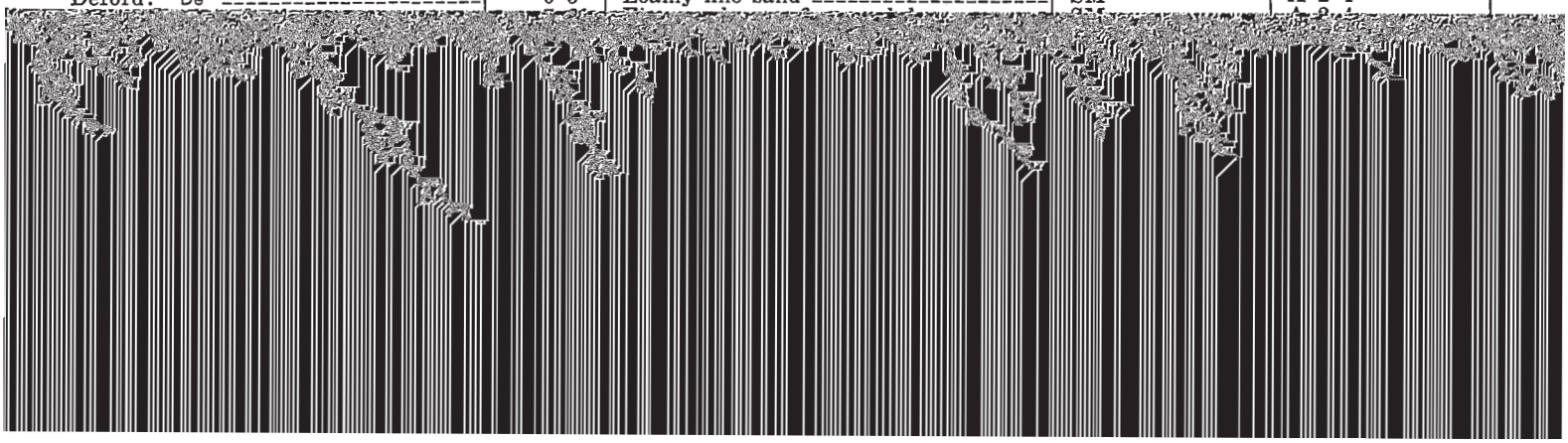


TABLE 11.—*Engineering*

[The symbol < means less than and > means more than. Absence of an

| Soil name and map symbol | Depth | USDA texture | Classification | |
|---|---|---|---|---|
| | | | Unified | AASHTO |
| | *In* | | | |
| Allendale: AdA | 0–11 | Loamy fine sand | SM | A–2–4 |
| | 11–39 | Sand, loamy sand, loamy fine sand | SP, SM | A–2–4, A–3 |
| | 39–60 | Silty clay, clay | CH, MH | A–7 |
| Angelica: Ax | 0–8 | Silt loam | ML, CL, CL–ML | A–4 |
| | 8–29 | Loam, sandy loam, clay loam | SM, ML, SC, CL | A–4, A–6 |
| | 29–60 | Loam, sandy loam, gravelly loam | ML, SM, CL, SC | A–2–4, A–4 |
| Bellevue: Bc | 0–35 | Silt loam | ML, CL–ML | A–4 |
| | 35–60 | Loam, sandy loam, silt loam | SC, SM–SC, CL, CL–ML | A–4, A–6, A–2 |
| Bonduel: BnA | 0–10 | Silt loam | ML, CL, CL–ML | A–4 |
| | 10–20 | Sandy clay loam, clay loam, loam | CL, SC | A–4, A–6 |
| | 20–24 | Loam | CL, CL–ML | A–4, A–6 |
| | 24–60 | Unweathered bedrock. | | |
| Borth: BoA | 0–14 | Silt loam | CL, CL–ML | A–4, A–6 |
| | 14–18 | Silt loam, silty clay loam, clay loam | CL | A–6 |
| | 18–33 | Silty clay, clay | CH | A–7 |
| | 33–60 | Sand, loamy sand, gravel | SP–SM, SM | A–2, A–3 |
| Boyer: BrB, BrC2, BrD2 | 0–14 | Loamy sand | SM, SM–SC | A–2 |
| | 14–28 | Sandy loam, sandy clay loam, loamy sand. | SM, SC, SM–SC | A–2, A–4, A–6 |
| | 28–60 | Stratified sand to gravel | SP, SP–SM, GP, GP–GM | A–1, A–3, A–2–4 |
| Briggsville: BtA, BtB | 0–11 | Silt loam | CL–ML, CL, ML | A–4, A–6 |
| | 11–27 | Silty clay, silty clay loam | CH, CL | A–6, A–7 |
| | 27–60 | Silty clay loam | CL, CH | A–6, A–7 |
| Carbondale: Ca | 0–34 | Sapric material | Pt | A–8 |
| | 34–60 | Hemic material | Pt | A–8 |
| Casco: CcB, CcC2, CcD2 | 0–7 | Loam | ML, CL–ML | A–4 |
| | 7–19 | Clay loam, loam, sandy clay loam | SC, CL | A–6, A–7 |
| | 19–60 | Sand and gravel | GP, SP, GP–GM, SP–SM | A–1, A–3, A–2 |
| Cathro: Cm | 0–33 | Sapric material | Pt | A–8 |
| | 33–60 | Sandy loam, loam, silt loam | SM, ML, SC, CL | A–4 |
| Channahon: CnB | 0–11 | Silt loam | CL | A–6, A–4 |
| | 11–18 | Loam, clay loam, silty clay loam | CL | A–6, A–7 |
| | 18–60 | Unweathered bedrock. | | |
| Deford: De | 0–5 | Loamy fine sand | SM | A–2–4 |



*properties and classifications*

entry indicates that data were not estimated. NP means nonplastic]

| Fragments > 3 inches | Percentage passing sieve number— | | | | Liquid limit | Plasticity index |
|---|---|---|---|---|---|---|
| | 4 | 10 | 40 | 200 | | |
| *Pct* | | | | | *Pct* | |
| 0 | 100 | 95–100 | 50–75 | 10–25 | | NP |
| 0 | 100 | 95–100 | 50–70 | 0–20 | | NP |
| 0 | 100 | 90–100 | 90–100 | 75–95 | 50–70 | 20–40 |
| 0–10 | 90–100 | 85–100 | 55–100 | 55–90 | 25–40 | 2–9 |
| 0–10 | 90–100 | 85–100 | 50–90 | 36–70 | 12–40 | 2–20 |
| 0–15 | 85–95 | 80–100 | 50–90 | 30–70 | 20–40 | NP–16 |
| 0 | 100 | 100 | 85–100 | 60–90 | 20–30 | 1–7 |
| 0 | 100 | 100 | 60–100 | 30–90 | 20–30 | 5–15 |
| 0 | 100 | 100 | 85–100 | 60–90 | 20–30 | 3–10 |
| 0–5 | 95–100 | 95–100 | 80–90 | 35–80 | 25–40 | 7–20 |
| 0–5 | 80–95 | 80–95 | 75–85 | 50–65 | 20–30 | 5–12 |
| 0 | 100 | 100 | 85–100 | 60–90 | 20–40 | 5–15 |
| 0 | 100 | 100 | 90–100 | 70–95 | 30–40 | 13–22 |
| 0 | 80–100 | 100 | 90–100 | 90–100 | 65–80 | 40–50 |
| 0 | 65–100 | 65–100 | 65–80 | 5–30 | | NP |
| 0–5 | 95–100 | 65–95 | 45–75 | 15–30 | <20 | NP–6 |
| 0–5 | 80–100 | 65–95 | 55–85 | 10–45 | 10–35 | NP–16 |
| 0–10 | 40–100 | 35–100 | 30–70 | 0–10 | | NP |

TABLE 11.—*Engineering properties*

| Soil name and map symbol | Depth | USDA texture | Classification | |
|---|---|---|---|---|
| | | | Unified | AASHTO |
| | *In* | | | |
| Hebron: HeB | 0–18 | Loam | ML, CL–ML | A–4 |
| | 18–28 | Clay loam, loam | CL–ML, CL | A–4, A–6 |
| | 28–32 | Silty clay loam | CL | A–7 |
| | 32–60 | Stratified silty clay to fine sand | CL | A–6, A–7 |
| Hortonville: | | | | |
| HnB, HnC2 | 0–8 | Fine sandy loam | SM, ML | A–4 |
| | 8–27 | Silty clay loam, clay loam, loam | CL, CH | A–7, A–6 |
| | 27–60 | Silty clay loam, clay loam, loam | CL, SC | A–4, A–6 |
| HrB, HrC2, HrD2, HrE, [1] HtB | 0–8 | Silt loam | ML, CL | A–4 |
| For Symco part of HtB, see Symco series. | 8–27 | Silty clay loam, clay loam, loam | CL, CH | A–7, A–6 |
| | 27–60 | Silty clay loam, clay loam, loam | CL, SC | A–4, A–6 |
| HsB, HsC2 | 0–10 | Silt loam | ML, CL, CL–ML | A–4 |
| | 10–30 | Silty clay loam | CL, CH | A–7, A–6 |
| | 30–45 | Clay loam | CL | A–6, A–4 |
| | 45–60 | Weathered bedrock. | | |
| Kaukauna: KaA | 0–9 | Silty clay loam | CL | A–6 |
| | 9–27 | Clay, silty clay | CH | A–7 |
| | 27–34 | Silt loam, loam, very fine sandy loam | CL, CL–ML | A–4, A–6 |
| | 34–60 | Stratified silt to very fine sand | CL, CL–ML, SC, SM–SC | A–4 |
| Keowns: Ke | 0–8 | Silt loam | ML, CL, CL–ML | A–4 |
| | 8–21 | Silt loam, very fine sandy loam, sandy loam. | ML, CL, SM, SC | A–4, A–2 |
| | 21–60 | Stratified silt to fine sand | ML, SM | A–2, A–4 |
| Kewaunee: | | | | |
| KhB, KhC2, KhD2, [1] KlB | 0–6 | Silt loam | ML, CL, CL–ML | A–4 |
| For Manawa part of KlB, see Manawa series. | 6–27 | Clay, silty clay, silty clay loam | CL, CH | A–7 |
| | 27–60 | Clay, silty clay, silty clay loam | CL, CH | A–6, A–7 |
| KkE3 | 0–6 | Silty clay loam | CL, CH | A–7 |
| | 6–27 | Clay, silty clay, silty clay loam | CL, CH | A–7 |
| | 27–60 | Clay, silty clay, silty clay loam | CL, CH | A–6, A–7 |
| Kolberg: KoB, KoC2 | 0–9 | Silt loam | ML, CL, CL–ML | A–4 |
| | 9–22 | Silty clay loam, silty clay, clay | CL, CH | A–6, A–7 |
| | 22–27 | Loam, clay loam, gravelly loam | CL, CL–ML | A–4, A–6 |
| | 27–60 | Weathered bedrock. | | |
| Limestone quarries: Ln. Not rated. | | | | |
| Lobo: Lo | 0–40 | Fibric material | Pt | A–8 |
| | 40–60 | Hemic material | Pt | A–8 |
| Manawa: McA | 0–11 | Silty clay loam | CL | A–6 |
| | 11–30 | Silty clay, silty clay loam, clay | CH, CL | A–7 |
| | 30–60 | Silty clay, silty clay loam, clay | CH, CL | A–6, A–7 |
| Manistee: | | | | |
| MeB, MeC2 | 0–14 | Loamy fine sand | SM | A–2–4 |
| | 14–31 | Sand, loamy sand | SP–SM, SM | A–2–4 |
| | 31–60 | Clay, silty clay | CH | A–7 |
| MfB | 0–14 | Fine sandy loam | SM | A–2–4, A–4 |
| | 14–31 | Sand, loamy sand | SP–SM, SM | A–2–4 |
| | 31–60 | Clay, silty clay | CH | A–7 |
| Markey: Mk | 0–25 | Sapric material | Pt | A–8 |
| | 25–60 | Sand, loamy sand | SP, SM | A–2, A–3 |

See footnote at end of table.

*and classifications*—Continued

| Fragments >3 inches | Percentage passing sieve number— | | | | Liquid limit | Plasticity index |
|---|---|---|---|---|---|---|
| | 4 | 10 | 40 | 200 | | |
| *Pct* | | | | | *Pct* | |
| 0 | 95–100 | 95–100 | 85–100 | 50–70 | 20–30 | NP–7 |
| 0 | 85–100 | 85–100 | 85–95 | 80–90 | 25–40 | 6–15 |
| 0 | 100 | 100 | 85–95 | 80–90 | 40–50 | 20–30 |
| 0 | 100 | 100 | 85–100 | 85–100 | 25–50 | 11–30 |
| 0 | 95–100 | 95–100 | 70–85 | 40–55 | 10–19 | 1–4 |
| 0 | 85–100 | 85–100 | 80–100 | 70–85 | 35–60 | 20–37 |
| 0–5 | 75–100 | 75–95 | 60–90 | 45–80 | 24–30 | 8–14 |
| 0 | 95–100 | 95–100 | 85–100 | 60–90 | 20–30 | 3–10 |
| 0 | 85–100 | 85–100 | 80–100 | 70–85 | 35–60 | 20–37 |
| 0–5 | 75–100 | 75–95 | 60–90 | 45–80 | 24–30 | 8–14 |
| 0 | 95–100 | 95–100 | 85–95 | 80–90 | 20–30 | 3–10 |
| 0 | 95–100 | 95–100 | 85–95 | 85–90 | 35–60 | 20–37 |
| 0–3 | 95–100 | 90–95 | 85–95 | 75–85 | 24–30 | 8–14 |
| 0 | 100 | 100 | 95–100 | 85–95 | 25–40 | 10–20 |
| 0 | 100 | 100 | 95–100 | 85–95 | 70–80 | 45–50 |
| 0 | 100 | 100 | 85–100 | 55–85 | 20–30 | 5–15 |
| 0 | 100 | 100 | 85–100 | 45–100 | <20 | 4–10 |
| 0 | 100 | 100 | 85–100 | 60–90 | 20–30 | 3–10 |
| 0 | 100 | 100 | 60–100 | 30–85 | <20 | NP–10 |
| 0 | 100 | 100 | 70–95 | 30–95 | <20 | NP–4 |
| 0 | 95–100 | 95–100 | 85–100 | 50–70 | 20–30 | 2–10 |
| 0 | 90–100 | 90–100 | 90–100 | 75–95 | 45–70 | 30–45 |
| 0 | 90–100 | 90–100 | 90–100 | 65–95 | 30–60 | 15–35 |
| 0 | 95–100 | 95–100 | 90–100 | 75–95 | 45–55 | 25–35 |
| 0 | 90–100 | 90–100 | 90–100 | 75–95 | 45–70 | 30–45 |
| 0 | 90–100 | 90–100 | 90–100 | 65–95 | 30–60 | 15–35 |
| 0 | 100 | 100 | 85–100 | 60–90 | 20–30 | 3–10 |
| 0 | 95–100 | 95–100 | 90–100 | 75–95 | 35–65 | 20–35 |
| 0 | 80–100 | 80–100 | 75–90 | 65–75 | 20–35 | 5–15 |
| 0 | | | | | | |
| 0 | | | | | | |
| 0 | 100 | 100 | 100 | 80–90 | 25–40 | 11–20 |
| 0 | 90–100 | 90–100 | 90–100 | 65–95 | 45–70 | 30–45 |
| 0–5 | 90–100 | 90–100 | 90–100 | 65–95 | 30–60 | 15–35 |
| 0–2 | 95–100 | 95–100 | 50–75 | 15–30 | | NP |
| 0–2 | 95–100 | 95–100 | 50–75 | 10–25 | | NP |
| 0 | 100 | 100 | 90–100 | 80–95 | 50–80 | 25–45 |
| 0–2 | 95–100 | 95–100 | 95–100 | 30–45 | <25 | NP–5 |
| 0–2 | 95–100 | 95–100 | 50–75 | 10–25 | | NP |
| 0 | 100 | 100 | 90–100 | 80–95 | 50–80 | 25–45 |
| 0 | 100 | 90–100 | 60–75 | 0–20 | | NP |

TABLE 11.—*Engineering properties*

| Soil name and map symbol | Depth | USDA texture | Classification | |
|---|---|---|---|---|
| | | | Unified | AASHTO |
| | *In* | | | |
| Menominee: MsB, MsC2 | 0–4 | Loamy fine sand | SM | A–2, A–4 |
| | 4–27 | Fine sand, very fine sand | SM, ML | A–2, A–4 |
| | 27–44 | Clay loam, loam, sandy clay loam | SC, SM–SC, CL, CL–ML | A–4, A–6 |
| | 44–60 | Sandy loam, loam | SC, SM–SC, CL, CL–ML | A–4, A–6, A–2 |
| Mosel: MtA | 0–9 | Silt loam | ML, CL–ML | A–4 |
| | 9–21 | Loam, sandy loam, sandy clay loam | SM–SC, SC, CL, CL–ML | A–4, A–6 |
| | 21–27 | Silty clay loam, silty clay, clay | CL | A–7 |
| | 27–60 | Stratified silty clay to fine sand | CL | A–7, A–6 |
| Mundelein: MuA | 0–10 | Silt loam | ML, CL, OL | A–4, A–6 |
| | 10–27 | Silty clay loam | CL | A–7, A–6 |
| | 27–60 | Stratified silt loam to sand | SC, SM, ML, CL | A–2, A–3, A–4, A–6 |
| Namur: NaB | 0–5 | Silt loam | ML | A–4 |
| | 5–60 | Weathered bedrock. | | |
| Nichols: | | | | |
| NfA, NfB | 0–26 | Very fine sandy loam | ML, CL–ML, SM, SM–SC | A–4 |
| | 26–60 | Stratified very fine sand to silt | ML, CL–ML, SM, SM–SC | A–4 |
| NsA, NsB | 0–26 | Very fine sandy loam | ML, CL–ML | A–4 |
| | 26–40 | Stratified very fine sand to silt | ML, CL–ML, SM, SM–SC | A–4 |
| | 40–60 | Clay | CH | A–7 |
| Onaway: OhB, OhC2, OhD2, [1] OlB<br>For Solona part of OlB, see Solona series. | 0–4 | Loam | ML, CL–ML, CL | A–4 |
| | 4–15 | Fine sandy loam, loam | SM, SM–SC | A–2, A–4 |
| | 15–27 | Loam, clay loam, silty clay loam | CL, CL–ML | A–4, A–6 |
| | 27–60 | Silt loam, loam, sandy loam | CL–ML, SC, CL, SM–SC | A–4 |
| Pella: Pe | 0–14 | Silt loam | CL, CL–ML | A–4 |
| | 14–29 | Silty clay loam | CL | A–6, A–7 |
| | 29–60 | Stratified sandy loam to silty clay loam. | SM–SC, SC, CL, CL–ML | A–2, A–4, A–6 |
| Poy: Pf | 0–8 | Silty clay loam | CL | A–6 |
| | 8–24 | Clay, silty clay loam, silty clay | CH | A–7 |
| | 24–60 | Sand, gravelly sand | SP | A–3 |
| Poygan: Po | 0–8 | Silty clay loam | CL, CH | A–7 |
| | 8–24 | Silty clay, silty clay loam, clay | CL, CH | A–7 |
| | 24–60 | Clay, silty clay | CL, CH | A–7, A–6 |
| Rock outcrop: Ra.<br>Not rated. | | | | |
| Rondeau: Rd | 0–22 | Sapric material | Pt | A–8 |
| | 22–60 | Marl | OH, MH | A–8, A–5 |
| Rousseau: RoB | 0–3 | Loamy fine sand | SM | A–2–4, A–4 |
| | 3–21 | Fine sand | SP, SP–SM | A–3, A–2–4 |
| | 21–60 | Fine sand | SP, SP–SM | A–3 |
| Shawano: SeC, SeD | 0–5 | Fine sand | SP, SM | A–2 |
| | 5–28 | Fine sand, very fine sand | SP, SM | A–2 |
| | 28–60 | Fine sand | SP, SM | A–2 |
| Shiocton: | | | | |
| ShA | 0–10 | Silt loam | ML, CL–ML, CL | A–4 |
| | 10–26 | Silt loam, very fine sandy loam | ML, CL–ML | A–4 |

*and classifications*—Continued

| Fragments >3 inches | Percentage passing sieve number— | | | | Liquid limit | Plasticity index |
|---|---|---|---|---|---|---|
| | 4 | 10 | 40 | 200 | | |
| *Pct* | | | | | *Pct* | |
| 0 | 100 | 100 | 60–80 | 30–40 | | NP |
| 0 | 100 | 100 | 65–80 | 20–60 | | NP |
| 0 | 95–100 | 95–100 | 80–100 | 35–80 | 20–30 | 5–15 |
| 0 | 95–100 | 95–100 | 60–95 | 30–75 | 15–30 | 5–12 |
| 0 | 95–100 | 95–100 | 85–100 | 50–70 | 20–30 | NP–5 |
| 0 | 90–100 | 90–100 | 45–70 | 40–65 | 20–40 | 5–25 |
| 0 | 100 | 100 | 85–100 | 85–95 | 40–50 | 20–30 |
| 0 | 100 | 100 | 85–100 | 85–100 | 25–50 | 10–30 |
| 0 | 95–100 | 95–100 | 95–100 | 85–95 | 30–50 | 5–20 |
| 0 | 95–100 | 95–100 | 95–100 | 75–95 | 35–50 | 15–25 |
| 0 | 90–100 | 90–100 | 60–90 | 10–75 | <35 | NP–20 |
| 0–5 | 90–100 | 90–100 | 85–100 | 60–90 | 20–30 | NP–5 |
| 0 | 100 | 100 | 75–95 | 45–60 | <20 | 2–6 |
| 0 | 100 | 95–100 | 85–100 | 75–100 | <20 | NP–6 |
| 0 | 100 | 100 | 85–95 | 50–65 | <20 | NP–5 |
| 0 | 100 | 95–100 | 75–95 | 35–95 | <20 | NP–6 |
| 0 | 100 | 100 | 100 | 95–100 | 65–75 | 40–50 |
| 0–30 | 90–100 | 90–100 | 75–90 | 60–70 | <25 | NP–10 |
| 0–30 | 90–100 | 85–95 | 55–80 | 25–50 | <20 | NP–10 |
| 0–20 | 95–100 | 95–100 | 80–95 | 65–90 | 25–35 | 7–15 |
| 0–20 | 90–95 | 85–95 | 60–95 | 36–80 | 15–25 | 4–10 |
| 0 | 100 | 100 | 90–100 | 70–90 | 20–30 | 5–10 |
| 0 | 100 | 95–100 | 85–100 | 70–95 | 30–50 | 20–30 |
| 0–5 | 90–100 | 80–100 | 50–100 | 30–85 | 20–35 | 7–20 |
| 0 | 100 | 100 | 95–100 | 80–90 | 30–40 | 10–20 |
| 0 | 100 | 100 | 95–100 | 80–95 | 60–90 | 40–60 |
| 0 | 65–100 | 65–100 | 50–60 | 1–5 | | NP |
| 0 | 100 | 100 | 90–100 | 75–95 | 45–55 | 25–35 |
| 0 | 90–100 | 90–100 | 90–100 | 75–95 | 45–70 | 30–45 |
| 0–5 | 90–100 | 90–100 | 90–100 | 80–100 | 30–55 | 20–45 |
| 0 | | | | | | NP |
| 0 | 100 | 95–100 | 80–90 | 60–80 | 50–90 | NP–10 |
| 0 | 100 | 100 | 75–95 | 25–45 | | NP |
| 0 | 100 | 100 | 90–100 | 5–25 | | NP |
| 0 | 100 | 100 | 85–100 | 0–10 | | NP |
| 0 | 100 | 100 | 75–100 | 5–35 | | NP |
| 0 | 95–100 | 95–100 | 70–100 | 3–35 | | NP |
| 0 | 95–100 | 95–100 | 70–100 | 2–25 | | NP |
| 0 | 100 | 100 | 85–100 | 65–95 | 20–30 | 3–8 |
| 0 | 100 | 100 | 85–100 | 50–90 | <30 | NP–6 |
| 0 | 100 | 100 | 80–100 | 40–95 | <30 | NP |

TABLE 11.—*Engineering properties*

| Soil name and map symbol | Depth | USDA texture | Classification | |
|---|---|---|---|---|
| | | | Unified | AASHTO |
| | *In* | | | |
| SkA | 0–8 | Silt loam | ML, CL, CL–ML | A–4 |
| | 8–16 | Loamy very fine sand, very fine sandy loam. | ML, CL–ML, SM, SM–SC | A–4 |
| | 16–50 | Very fine sand, very fine sandy loam | ML, CL–ML, SM, SM–SC | A–4 |
| | 50–60 | Silty clay, clay | CL, CH | A–7 |
| [1] SnB | 0–10 | Silt loam | ML, CL–ML, CL | A–4 |
| For Nichols part, see NfB in Nichols series. | 10–26 | Silt loam, very fine sandy loam | ML, CL–ML | A–4 |
| | 26–60 | Stratified silt to very fine sand | ML | A–4 |
| Solona: SoA | 0–11 | Silt loam | ML, CL, CL–ML | A–4 |
| | 11–24 | Clay loam, loam, sandy loam | CL, SC | A–6 |
| | 24–60 | Loam, sandy loam | ML, CL, SM, SC | A–2, A–4, A–6 |
| Suamico: Su | 0–26 | Sapric material | Pt | A–8 |
| | 26–60 | Silty clay, clay, clay loam | CL, CH | A–7 |
| Symco: SyA | 0–11 | Silt loam | ML | A–4 |
| | 11–25 | Clay loam, silt loam, silty clay loam | CL | A–6 |
| | 25–60 | Loam, clay loam, silty clay loam | CL | A–6 |
| Symco variant: SzA | 0–12 | Silt loam | ML, CL | A–4 |
| | 12–22 | Silty clay loam, clay loam | CL | A–6, A–4 |
| | 22–26 | Sandy loam | SM, SM–SC | A–2, A–4 |
| | 26–60 | Sand and gravel | GP, SP, SP–SM, GP–GM | A–1, A–3 |
| Udifluvents: Uf | 0–60 | Variable | | |
| Udorthents: Uo | 0–60 | Variable | | |
| Wainola: WaA | 0–9 | Loamy fine sand | SM | A–2–4 |
| | 9–33 | Fine sand, loamy fine sand | SM | A–2–4 |
| | 33–60 | Fine sand, loamy fine sand | SM | A–2–4 |
| Will: Wb | 0–10 | Silt loam | CL, ML | A–7, A–6 |
| | 10–26 | Loam, clay loam, silty clay loam | CL, CH | A–7 |
| | 26–60 | Stratified sand to gravelly loamy sand | GP, GP–GM, SP, SP–SM | A–1 |
| Winneconne: WnA, WnB, WnC2 | 0–9 | Silty clay loam | CH | A–7 |
| | 9–31 | Clay, silty clay | CH | A–7 |
| | 31–60 | Clay | CH | A–7 |
| Zittau: ZtA | 0–11 | Silty clay loam | CL | A–6, A–7 |
| | 11–32 | Silty clay, clay | CH | A–7 |
| | 32–60 | Sand, loamy sand, sand and gravel | SP, SM | A–3, A–2 |

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and

an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

*Soil reaction* is expressed as a range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

*Shrink-swell potential* depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

*Risk of corrosion* pertains to potential soil-induced

*and classifications*—Continued

| Fragments >3 inches | Percentage passing sieve number— | | | | Liquid limit | Plasticity index |
|---|---|---|---|---|---|---|
| | 4 | 10 | 40 | 200 | | |
| *Pct* | | | | | *Pct* | |
| 0 | 100 | 100 | 90–100 | 70–90 | 20–30 | 3–8 |
| 0 | 100 | 100 | 85–95 | 40–65 | <30 | NP–6 |
| 0 | 100 | 100 | 75–95 | 35–65 | <30 | NP–6 |
| 0 | 100 | 100 | 95–100 | 90–95 | 45–55 | 25–32 |
| 0 | 100 | 100 | 85–100 | 65–95 | 20–30 | 3–8 |
| 0 | 100 | 100 | 85–100 | 50–90 | <30 | NP–6 |
| 0 | 100 | 100 | 80–100 | 40–95 | <30 | NP |
| 0 | 90–100 | 85–100 | 75–85 | 60–80 | 20–30 | 1–10 |
| 0–3 | 90–100 | 85–100 | 75–95 | 40–65 | 25–35 | 10–20 |
| 0–5 | 85–95 | 80–90 | 70–85 | 30–60 | <24 | NP–12 |
| 0 | | | | | | |
| 0 | 100 | 100 | 90–100 | 70–95 | 40–60 | 25–35 |
| 0 | 100 | 100 | 90–95 | 70–80 | 20–30 | NP–5 |
| 0–5 | 95–100 | 90–95 | 85–95 | 75–85 | 25–40 | 11–20 |
| 0–5 | 95–100 | 90–95 | 85–95 | 75–85 | 25–40 | 11–20 |
| 0 | 100 | 100 | 90–100 | 70–90 | 20–30 | 3–10 |
| 0–5 | 95–100 | 90–100 | 90–100 | 70–95 | 25–40 | 10–20 |
| 0–5 | 95–100 | 90–100 | 60–70 | 30–40 | 10–19 | 2–6 |
| 0–10 | 40–80 | 35–70 | 30–55 | 0–10 | | NP |
| | | | | | | |
| | | | | | | |
| 0 | 100 | 95–100 | 55–80 | 20–35 | | NP |
| 0 | 100 | 95–100 | 50–80 | 15–35 | | NP |
| 0 | 100 | 95–100 | 50–80 | 15–35 | | NP |
| 0 | 95–100 | 95–100 | 90–100 | 60–90 | 35–50 | 15–25 |
| 0–5 | 90–100 | 90–100 | 80–100 | 60–90 | 40–60 | 20–35 |
| 1–10 | 40–80 | 40–70 | 40–50 | 0–10 | | NP |
| 0 | 100 | 100 | 95–100 | 85–95 | 70–80 | 40–45 |
| 0 | 100 | 100 | 90–100 | 70–95 | 70–80 | 45–50 |
| 0 | 100 | 100 | 90–100 | 75–100 | 70–80 | 45–50 |
| 0 | 100 | 100 | 95–100 | 85–95 | 25–45 | 11–20 |
| 0 | 100 | 100 | 100 | 85–95 | 60–70 | 30–40 |
| 0 | 85–100 | 65–100 | 60–85 | 1–20 | | NP |

behavior characteristics of the mapping unit.

chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel

*Erosion factors* are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope

TABLE 12.—*Physical and chemical properties of soils*

[The symbol < means less than and > means more than. The erosion tolerance factor (T) and wind erodibility group are for the entire profile. Absence of an entry indicates that data were not estimated. Dashes indicate that data were not available]

| Soil name and map symbol | Depth | Permeability | Available water capacity | Soil reaction | Shrink-swell potential | Risk of corrosion | | Erosion factors | | Wind erodibility group |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Uncoated steel | Concrete | K | T | |
| | *In* | *In per hr* | *In per in* | *pH* | | | | | | |
| Allendale: AdA | 0–11 | 2.0–20 | 0.07–0.12 | 5.1–7.3 | Low | Low | Moderate | 0.15 | 4 | 2 |
| | 11–39 | 6.0–20 | 0.06–0.10 | 5.1–7.3 | Low | Low | Moderate | 0.15 | | |
| | 39–60 | 0.06–0.2 | 0.08–0.12 | 6.1–8.4 | High | High | Low | 0.32 | | |
| Angelica: Ax | 0–8 | 0.6–2.0 | 0.18–0.22 | 6.1–7.3 | Low | High | Low | | | 5 |
| | 8–29 | 0.6–2.0 | 0.10–0.18 | 6.1–7.3 | Low | High | Low | | | |
| | 29–60 | 0.2–0.6 | 0.10–0.20 | 7.9–8.4 | Low | High | Low | | | |
| Bellevue: Bc | 0–35 | 0.6–2.0 | 0.20–0.24 | 6.1–8.4 | Low | Low | Low | 0.32 | 5 | 5 |
| | 35–60 | 0.6–2.0 | 0.12–0.19 | 6.1–8.4 | Low | Low | Low | 0.32 | | |
| Bonduel: BnA | 0–10 | 0.6–2.0 | 0.20–0.24 | 6.6–7.8 | Low | Moderate | Low | 0.28 | 4–3 | 5 |
| | 10–20 | 0.6–2.0 | 0.15–0.19 | 5.6–7.8 | Moderate | Moderate | Low | 0.28 | | |
| | 20–24 | 0.6–2.0 | 0.17–0.19 | 6.6–8.4 | Low | Moderate | Low | 0.28 | | |
| | 24–60 | | | | | | | | | |
| Borth: BoA | 0–14 | 0.6–2.0 | 0.20–0.24 | 5.6–8.4 | Low | High | Low | 0.43 | 3–2 | 6 |
| | 14–18 | 0.2–0.6 | 0.15–0.22 | 5.6–8.4 | Moderate | High | Low | 0.43 | | |
| | 18–33 | 0.06–0.2 | 0.09–0.13 | 5.6–8.4 | Moderate | High | Low | 0.32 | | |
| | 33–60 | 6.0–20 | 0.05–0.10 | 6.6–8.4 | Low | Low | Low | 0.15 | | |
| Boyer: BrB, BrC2, BrD2. | 0–14 | 6.0–20 | 0.10–0.12 | 5.6–7.3 | Low | Low | Moderate | 0.17 | 4–3 | 2 |
| | 14–28 | 2.0–6.0 | 0.12–0.18 | 5.6–7.3 | Low | Low | Moderate | 0.24 | | |
| | 28–60 | >20 | 0.02–0.04 | 6.1–7.3 | Low | Low | Low | 0.10 | | |
| Briggsville: BtA, BtB. | 0–11 | 0.6–2.0 | 0.20–0.24 | 5.1–6.0 | Low | Moderate | Moderate | 0.37 | 5–4 | 5 |
| | 11–27 | 0.2–0.6 | 0.11–0.20 | 6.1–8.4 | Moderate | High | Low | 0.37 | | |
| | 27–60 | 0.2–0.6 | 0.18–0.20 | 7.4–8.4 | Moderate | High | Low | 0.37 | | |

TABLE 12.—*Physical and chemical properties of soils*—Continued

| Soil name and map symbol | Depth | Permeability | Available water capacity | Soil reaction | Shrink-swell potential | Risk of corrosion | | Erosion factors | | Wind erodibility group |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Uncoated steel | Concrete | K | T | |
| | *In* | *In per hr* | *In per in* | *pH* | | | | | | |
| Hebron: HeB | 0–18 | 0.6–2.0 | 0.20–0.22 | 5.6–6.5 | Low | Low | Low | 0.32 | 5–4 | 6 |
| | 18–28 | 0.6–2.0 | 0.15–0.19 | 5.6–6.5 | Moderate | Moderate | Low | 0.32 | | |
| | 28–32 | 0.2–0.6 | 0.18–0.20 | 6.6–8.4 | Moderate | Moderate | Low | 0.32 | | |
| | 32–60 | 0.2–0.6 | 0.18–0.20 | 7.4–8.4 | Moderate | Moderate | Low | 0.43 | | |
| Hortonville: | | | | | | | | | | |
| HnB, HnC2 | 0–8 | 0.6–2.0 | 0.16–0.18 | 5.6–7.3 | Low | Low | Moderate | 0.24 | 5–4 | 3 |
| | 8–27 | 0.2–2.0 | 0.15–0.20 | 5.6–7.8 | Moderate | Moderate | Moderate | 0.37 | | |
| | 27–60 | 0.2–2.0 | 0.15–0.20 | 7.4–8.4 | Low | Moderate | Moderate | 0.37 | | |
| HrB, HrC2, HrD2, HrE, [1] HtB. For Symco part of HtB, see Symco series. | 0–8 | 0.6–2.0 | 0.20–0.24 | 5.6–7.3 | Low | Low | Moderate | 0.37 | 5–4 | 5 |
| | 8–27 | 0.2–2.0 | 0.15–0.20 | 5.6–7.8 | Moderate | Moderate | Moderate | 0.37 | | |
| | 27–60 | 0.2–2.0 | 0.15–0.20 | 7.4–8.4 | Low | Moderate | Moderate | 0.37 | | |
| HsB, HsC2 | 0–10 | 0.6–2.0 | 0.22–0.24 | 5.1–7.3 | Low | Low | Moderate | 0.37 | 5–4 | 5 |
| | 10–30 | 0.2–2.0 | 0.18–0.20 | 5.1–7.8 | Moderate | Moderate | Moderate | 0.37 | | |
| | 30–45 | 0.2–2.0 | 0.14–0.16 | 5.1–7.8 | Moderate | Moderate | Moderate | 0.37 | | |
| | 45–60 | | | | | | | | | |
| Kaukauna: | | | | | | | | | | |
| KaA. | 0–9 | 0.6–2.0 | 0.21–0.23 | 5.6–7.8 | Low | Moderate | Moderate | 0.37 | 3 | 4 |
| | 9–27 | >0.2 | 0.09–0.13 | 6.6–8.4 | High | Moderate | Low | 0.37 | | |
| | 27–34 | 0.2–2.0 | 0.17–0.22 | 6.6–8.4 | Low | Moderate | Low | 0.37 | | |
| | 34–60 | 0.2–2.0 | 0.17–0.22 | 7.4–8.4 | Low | Moderate | Low | 0.37 | | |
| Keowns: Ke | 0–8 | 0.6–2.0 | 0.20–0.24 | 6.6–8.4 | Low | High | Low | | | 5 |
| | 8–21 | 0.6–2.0 | 0.12–0.22 | 6.6–8.4 | Low | High | Low | | | |
| | 21–60 | 0.6–2.0 | 0.11–0.22 | 7.4–8.4 | Low | High | Low | | | |
| Kewaunee: | | | | | | | | | | |
| KhB, KhC2, KhD2, [1] KlB. For Manawa part of KlB, see Manawa series. | 0–6 | 0.6–2.0 | 0.20–0.24 | 5.6–7.3 | Low | Low | Low | 0.37 | 3 | 5 |
| | 6–27 | 0.06–0.6 | 0.09–0.13 | 5.6–7.8 | Moderate | Moderate | Low | 0.37 | | |
| | 27–60 | 0.2–0.6 | 0.08–0.20 | 7.4–8.4 | Moderate | Moderate | Low | 0.37 | | |
| KkE3 | 0–6 | 0.2–0.6 | 0.21–0.23 | 5.6–7.3 | Moderate | Moderate | Low | 0.37 | 3 | 4 |
| | 6–27 | 0.06–0.6 | 0.09–0.13 | 5.6–7.8 | Moderate | Moderate | Low | 0.37 | | |
| | 27–60 | 0.2–0.6 | 0.08–0.20 | 7.4–8.4 | Moderate | Moderate | Low | 0.37 | | |
| Kolberg: KoB, KoC2. | 0–9 | 0.6–2.0 | 0.20–0.24 | 5.6–7.3 | Low | Moderate | Moderate | 0.43 | 3–2 | 5 |
| | 9–22 | 0.06–0.6 | 0.09–0.20 | 6.6–7.8 | Moderate | Moderate | Low | 0.32 | | |
| | 22–27 | 0.2–2.0 | 0.15–0.19 | 6.6–7.8 | Moderate | Moderate | Low | 0.32 | | |
| | 27–60 | | | | | | | | | |
| Limestone quarries: Ln. Not rated. | | | | | | | | | | |
| Lobo: Lo | 0–40 | >6.0 | 0.55–0.65 | 3.6–4.4 | | High | High | | | 8 |
| | 40–60 | 0.6–6.0 | 0.45–0.55 | 3.6–5.0 | | High | High | | | |
| Manawa: McA | 0–11 | 0.2–0.6 | 0.21–0.23 | 6.6–7.8 | Moderate | Low | Low | 0.37 | 3–2 | 7 |
| | 11–30 | 0.06–0.2 | 0.09–0.20 | 6.1–8.4 | Moderate | High | Low | 0.37 | | |
| | 30–60 | 0.06–0.2 | 0.08–0.20 | 7.9–8.4 | Moderate | High | Low | 0.37 | | |
| Manistee: | | | | | | | | | | |
| MeB, MeC2 | 0–14 | 6.0–20 | 0.10–0.12 | 5.1–6.5 | Very low | Low | Moderate | 0.17 | 4–3 | 2 |
| | 14–31 | 6.0–20 | 0.06–0.10 | 5.6–7.3 | Very low | Low | Moderate | 0.17 | | |
| | 31–60 | 0.06–0.2 | 0.08–0.12 | 7.4–8.4 | High | High | Low | 0.32 | | |

See footnote at end of table.

TABLE 12.—*Physical and chemical properties of soils*—Continued

| Soil name and map symbol | Depth | Permeability | Available water capacity | Soil reaction | Shrink-swell potential | Risk of corrosion | | Erosion factors | | Wind erodibility group |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Uncoated steel | Concrete | K | T | |
| | *In* | *In per hr* | *In per in* | *pH* | | | | | | |
| MfB | 0–14 | 2.0–6.0 | 0.13–0.15 | 5.1–6.5 | Very low | Low | Moderate | 0.24 | 4–3 | 3 |
| | 14–31 | 6.0–20 | 0.06–0.10 | 5.6–7.3 | Very low | Low | Moderate | 0.17 | | |
| | 31–60 | 0.06–0.2 | 0.08–0.12 | 7.4–8.4 | High | High | Low | 0.32 | | |

TABLE 12.—*Physical and chemical properties of soils*—Continued

| Soil name and map symbol | Depth | Permeability | Available water capacity | Soil reaction | Shrink-swell potential | Risk of corrosion | | Erosion factors | | Wind erodibility group |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Uncoated steel | Concrete | K | T | |
| | *In* | *In per hr* | *In per in* | *pH* | | | | | | |
| Shawano: SeC, SeD. | 0–5 | 6.0–20 | 0.07–0.09 | 5.6–6.5 | Low | Low | Moderate | 0.15 | 5 | 1 |
| | 5–28 | 6.0–20 | 0.06–0.08 | 5.6–6.5 | Low | Low | Moderate | 0.15 | | |
| | 28–60 | 6.0–20 | 0.05–0.07 | 5.6–7.8 | Low | Low | Moderate | 0.15 | | |

quality. The rate is expressed in tons of soil loss per acre per year.

*Wind erodibility groups* are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

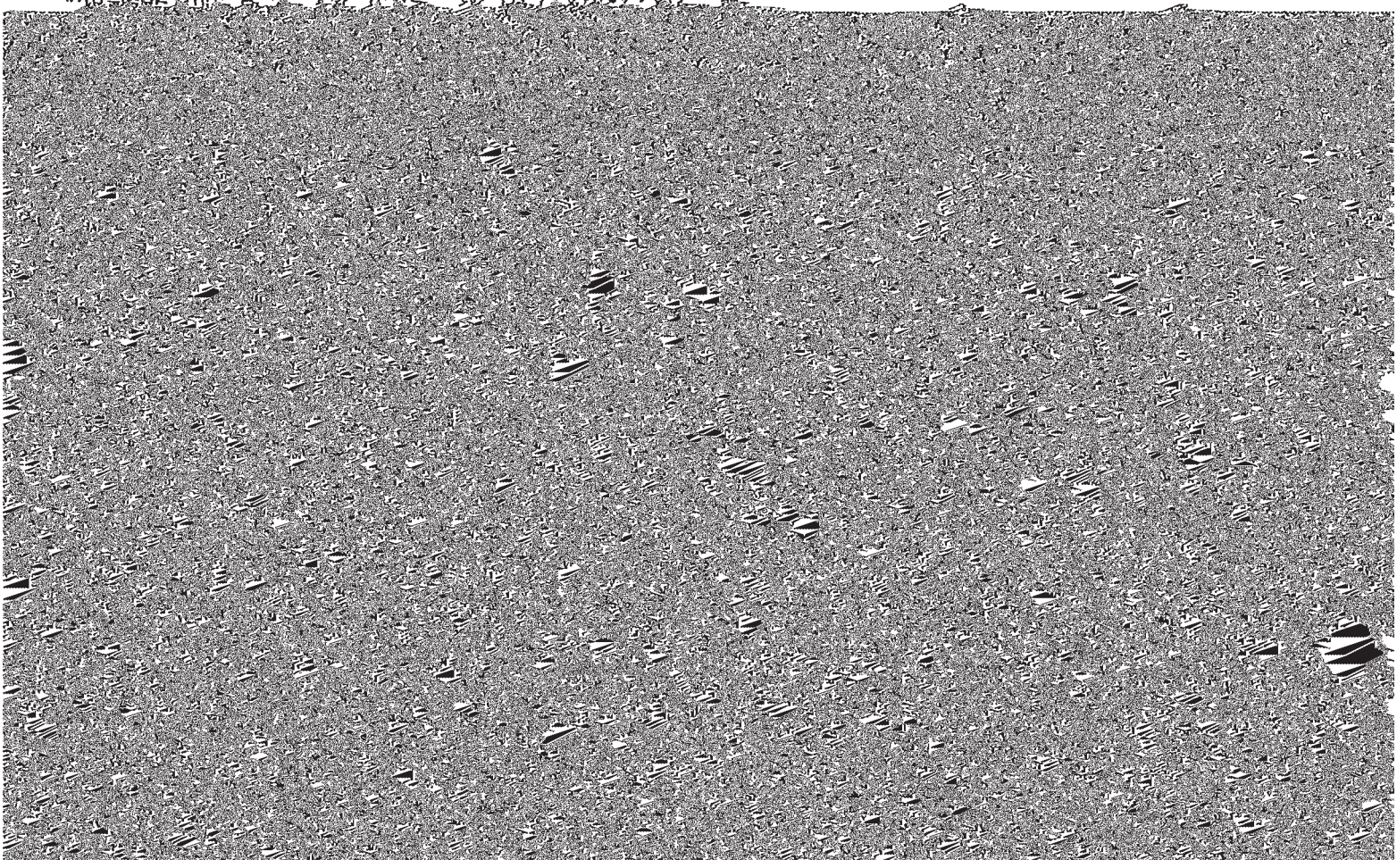
4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.
5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium car-

drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

*Flooding* is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to



many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attach-

## Factors of Soil Formation

Soil is produced by soil-forming processes that act on geologic deposits. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has

TABLE 13.—*Soil and*

[The definitions of "flooding" and "water table" in the Glossary explain the terms "brief," "apparent," and "perched."

| Soil name and map symbol | Hydrologic group | Flooding | | |
|---|---|---|---|---|
| | | Frequency | Duration | Months |
| Allendale: AdA | B | Rare | | |
| Angelica: Ax | B/D | Frequent | Long | Nov. to May |
| Bellevue: Bc | B | Frequent | Brief | Sept. to May |
| Bonduel: BnA | C | None | | |
| Borth: BoA | C | None | | |
| Boyer: BrB, BrC2, BrD2 | B | None | | |
| Briggsville: BtA, BtB | C | None | | |
| Carbondale: Ca | D | Frequent | Long | Nov. to May |
| Casco: CcB, CcC2, CcD2 | B | None | | |
| Cathro: Cm | D | Frequent | Long | Nov. to May |
| Channahon: CnB | D | None | | |
| Deford: De | A/D | Frequent | Brief | Mar. to Apr. |
| Eleva: ElB, ElC2 | B | None | | |
| Fluvaquents: Fu | D | Frequent | Very long | Mar. to Nov. |
| Gravel pits: Gp. Not rated. | | | | |
| Grays: GrA, GrB | B | None | | |
| Hebron: HeB | C | None | | |
| Hortonville: HnB, HnC2, HrB, [1] HtB, HrC2, HrD2, HrE. For Symco part of HtB, see Symco series. | B | None | | |
| HsB, HsC2 | B | None | | |
| Kaukauna: KaA | C | None | | |
| Keowns: Ke | B/D | Frequent | Brief | Mar. to Apr. |
| Kewaunee: KhB, KhC2, KhD2, KhE3, [1] KlB. For Manawa part of KlB, see Manawa series. | C | None | | |
| Kolberg: KoB, KoC2 | B | None | | |
| Limestone quarries: Ln. Not rated. | | | | |
| Lobo: Lo | D | None | | |
| Manawa: McA | C | Occasional | Brief | Nov. to May |
| Manistee: MeB, MeC2, MfB | A | None | | |
| Markey: Mk | D | Frequent | Long | Nov. to May |
| Menominee: MsB, MsC2 | B | None | | |

See footnote at end of table.

*water features*

The symbol < means less than and > means more than. Absence of an entry indicates that the feature is not a concern]

| High water table | | | Bedrock | | Subsidence (total) | Potential frost action |
|---|---|---|---|---|---|---|
| Depth | Kind | Months | Depth | Hardness | | |
| *Ft* | | | *In* | | *In* | |
| 0.5–1.5 | Apparent | Nov. to May | >60 | | | Moderate. |
| 0–1.0 | Apparent | Oct. to June | >60 | | | High. |
| 3.0–6.0 | Apparent | Sept. to May | >60 | | | Moderate. |
| 1.0–3.0 | Apparent | Sept. to June | 20–40 | Rippable | | High. |
| 3.0–6.0 | Apparent | Nov. to May | >60 | | | Moderate. |
| >6.0 | | | >60 | | | Low. |
| 3.0–6.0 | Apparent | Mar. to May | >60 | | | High. |
| 0–1.0 | Apparent | Sept. to May | >60 | | | High. |
| >6.0 | | | >60 | | | Low. |
| 0–1.0 | Apparent | Nov. to June | >60 | | 19–22 | High. |
| >6.0 | | | 10–20 | Hard | | Moderate. |
| 0–1.0 | Apparent | Jan. to May | >60 | | | Moderate. |
| >6.0 | | | 20–40 | Rippable | | Moderate. |
| 0–1.0 | Apparent | Jan. to Dec. | >60 | | | High. |
| 4.0–6.0 | Apparent | Feb. to Mar. | >60 | | | High. |
| 3.0–6.0 | Apparent | Mar. to May | >60 | | | Moderate. |
| >6.0 | | | >60 | | | Moderate. |
| >6.0 | | | 40–60 | Rippable | | Moderate. |
| 3.0–6.0 | Apparent | Nov. to May | >60 | | | Moderate. |
| 0–1.0 | Apparent | Oct. to May | >60 | | | High. |
| >3.0 | Perched | Nov. to May | >60 | | | Moderate. |
| >6.0 | | | 20–40 | Rippable | | Moderate. |
| 0–2.0 | Apparent | Jan. to Dec. | >60 | | 55–50 | High. |
| 1.0–3.0 | Perched | Nov. to June | >60 | | | High. |
| >6.0 | | | >60 | | | Low. |
| 0–1.0 | Apparent | Nov. to June | >60 | | 25–30 | High. |
| >6.0 | | | >60 | | | Moderate. |

TABLE 13.—*Soil and*

| Soil name and map symbol | Hydrologic group | Flooding | | |
|---|---|---|---|---|
| | | Frequency | Duration | Months |
| Mosel: MtA | C | Rare | | |
| Mundelein: MuA | B | None | | |
| Namur: NaB | D | None | | |
| Nichols: NfA, NfB | B | None | | |
| NsA, NsB | B | None | | |
| Onaway: OhB, OhC2, OhD2, [1] OlB<br>For Solona part of OlB, see Solona series. | B | None | | |
| Pella: Pe | B/D | Occasional | Brief | Mar. to June |
| Poy: Pf | D | Frequent | Long | Nov. to May |
| Poygan: Po | D | Frequent | Long | Nov. to June |
| Rock outcrop: Ra.<br>Not rated. | | | | |
| Rondeau: Rd | D | Frequent | Long | Nov. to May |
| Rousseau: RoB | A | None | | |
| Shawano: SeC, SeD | A | None | | |
| Shiocton: ShA, [1] SnB<br>For Nichols part of SnB, see NfB in Nichols series. | B | Occasional | Long | Mar. to May |
| SkA | C | Frequent | Long | Mar. to June |
| Solona: SoA | B | Occasional | Brief | Apr. to June |
| Suamico: Su | D | Frequent | Very long | Nov. to May |
| Symco: SyA | B | Rare | | |
| Symco variant: SzA | B | Occasional | Brief | Apr. to May |
| Udifluvents: Uf | C | Occasional | Brief | Apr. to Nov. |
| Udorthents: Uo | C | None | | |
| Wainola: WaA | A | Rare | | |
| Will: Wb | B/D | Occasional | Brief | Apr. to June |
| Winneconne: WnA, WnB, WnC2 | C | None | | |
| Zittau: ZtA | C | Occasional | Long | Nov. to May |

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and

to steep on morainal uplands. In depressions, runoff is slow and internal drainage generally is slow. Because soils in these areas remain wet and cool, they develop mottles throughout their profile; and because they are covered by slowly decomposing surface litter, they develop a thick surface layer that is high in organic-matter content. Example of these soils are in the Angelica, Poygan, and Solona series.

Soils that formed in alluvium are along streams. They receive fresh deposits of silt, clay, and sand at a rate faster than their horizons can develop; thus their profiles do not exhibit specific horizonation as

*water features*—Continued

| High water table | | | Bedrock | | Subsidence (total) | Potential frost action |
|---|---|---|---|---|---|---|
| Depth | Kind | Months | Depth | Hardness | | |
| *Ft* | | | *In* | | *In* | |
| 1.0–3.0 | Apparent | Nov. to May | >60 | | | High. |
| 1.0–3.0 | Apparent | Mar. to June | >60 | | | High. |
| >6.0 | | | 5–12 | Hard | | Moderate. |
| 3.0–6.0 | Apparent | Nov. to May | >60 | | | High. |
| 3.0–6.0 | Apparent | Nov. to May | >60 | | | Moderate. |
| >2.0 | Apparent | Mar. to May | >60 | | | Moderate. |
| 0–2.0 | Apparent | Mar. to June | >60 | | | High. |
| 0–1.0 | Perched | Nov. to May | >60 | | | High. |
| 0–1.0 | Perched | Nov. to July | >60 | | | High. |
| 0–1.0 | Apparent | Jan. to Dec. | >60 | | 35 | High. |
| >2.5 | Apparent | Mar. to May | >60 | | | Low. |
| >6.0 | | | >60 | | | Low. |
| 1.0–3.0 | Apparent | Sept. to July | >60 | | | High. |
| 1.0–3.0 | Perched | Nov. to July | >60 | | | High. |
| 1.0–3.0 | Apparent | Mar. to July | >60 | | | High. |
| 0–1.0 | Apparent | Nov. to May | >60 | | 25–30 | High. |
| 1.0–3.0 | Apparent | Nov. to May | >60 | | | High. |
| 1.0–3.0 | Apparent | Nov. to June | >60 | | | High. |
| 1.0–6.0 | Apparent | Apr. to June | >60 | | | High. |
| >6.0 | | | >60 | | | Moderate. |
| 1.0–2.0 | Apparent | Nov. to May | >60 | | | Moderate. |
| 0–2.0 | Apparent | Mar. to June | >60 | | | High. |
| 3.0–6.0 | Apparent | Nov. to May | >60 | | | Moderate. |
| 1.0–2.5 | Apparent | Nov. to May | >60 | | | High. |

behavior characteristics of the mapping unit.

do those of older soils. Fluvaquents is an example of a soil that formed in alluvium.

Typical soils on uplands are in the Casco, Hebron, Hortonville, Kewaunee, and Winneconne series. Their profiles show distinct horizonation throughout. On some of the steep soils, however, erosion has removed one or two of the upper horizons and altered the physical nature of the soils.

### *Parent material*

Most soils in Outagamie County were derived either from material deposited by glaciers or from material

*test data*

Highways. Absence of an entry indicates that no determination was made]

| Percentage passing sieve—[2] | | | Percentage smaller than—[2] | | | | Liquid limit | Plasticity index | Classification | |
|---|---|---|---|---|---|---|---|---|---|---|
| No. 10 | No. 40 | No. 200 | 0.05 mm | 0.02 mm | 0.005 mm | 0.002 mm | | | AASHTO[3] | Unified[4] |
| | | | | | | | *Pct* | | | |
| 100 | 97 | 57 | 51 | 36 | 19 | 13 | 32.1 | 13.5 | A–6(6) | CL |
| 100 | 95 | 51 | 44 | 30 | 16 | 11 | 21.8 | 6.6 | A–4(3) | CL–ML |
| | | | | | | | | | | |
| | 100 | 97 | 97 | 96 | 91 | 77 | 74.7 | 48.3 | A–7–6(20) | CH |
| 100 | 94 | 30 | 20 | 9 | 7 | 5 | | [5]NP | A–2–4(0) | SM |
| | 100 | 85 | 79 | 56 | 29 | 23 | 33.6 | 14.2 | A–6(10) | CL |
| | | 98 | 92 | 53 | 13 | 9 | 24.1 | NP | A–4(8) | ML |
| 100 | 98 | 78 | 75 | 63 | 47 | 36 | 41.7 | 22.4 | A–7–6(13) | CL |
| 79 | 72 | 54 | 50 | 39 | 23 | 14 | 24.2 | 9.3 | A–4(4) | CL |
| | | 30 | 22 | 14 | 9 | 8 | | NP | A–2–4(0) | SM |
| 100 | 98 | 84 | 82 | 76 | 62 | 51 | 60.0 | 35.4 | A–7–6(20) | CH |
| 88 | 86 | 70 | 64 | 47 | 29 | 21 | 31.6 | 12.0 | A–6(8) | CL |
| 100 | 98 | 61 | 47 | 20 | 8 | 5 | | NP | A–4(5) | ML |
| 86 | 78 | 48 | 43 | 33 | 22 | 16 | 27.6 | 12.0 | A–6(4) | SC |
| | 100 | 87 | 78 | 42 | 18 | 13 | 25.4 | 3.5 | A–4(8) | ML |
| | | 90 | 82 | 30 | 8 | 4 | 19.5 | NP | A–4(8) | ML |
| 100 | 99 | 94 | 92 | 73 | 29 | 20 | 32.8 | 11.0 | A–6(8) | CL |
| 100 | 99 | 98 | 95 | 70 | 19 | 10 | 22.9 | 1.8 | A–4(8) | ML |
| 100 | 93 | 57 | 52 | 44 | 31 | 25 | 32 | 19 | A–6(8) | CL |

TABLE 14.—*Engineering*

| Soil name and location | Parent material | SCS report no. | Depth | Moisture density [1] | |
|---|---|---|---|---|---|
| | | | | Maximum | Optimum |
| | | | *In* | *lb/cu-ft* | *Pct* |
| Symco silt loam: NE¼, NE¼, NW¼, sec. 35, T. 21 N., R. 16 E. (Modal.) | Loamy deposits over loamy glacial till. | S73WI–44–3 | | | |
| | | 3–1 | 18–23 | | |
| | | 3–2 | 23–60 | | |
| Will silt loam: NW¼, NW¼, SW¼, sec. 20, T. 21 N., R. 15 E. (Modal.) | Loamy deposits over outwash sand and gravel. | S74WI–44–3 | | | |
| | | 3–1 | 10–20 | | |
| | | 3–2 | 24–60 | | |
| Winneconne silty clay loam: NE¼, SE¼, SE¼, sec. 7, T. 22 N., R. 15 E. (Modal.) | Silty and clayey lacustrine deposits. | S74WI–44–4 | | | |
| | | 4–1 | 13–27 | | |
| | | 4–2 | 31–60 | 95.2 | 26.0 |
| Zittau silty clay loam: NE¼, NE¼, SW¼, sec. 9, T. 24 N., R. 15 E. (Modal.) | Loamy and clayey lacustrine deposits underlain by sand. | S74WI–44–5 | | | |
| | | 5–1 | 18–28 | | |
| | | 5–2 | 32–60 | 114.3 | 12.5 |

[1] Based on AASHTO Designation T99–57, Method A (*1*).

[2] Mechanical analysis according to the AASHTO Designation T88–57 (*1*). Results by this procedure may differ somewhat from the results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all material up to and including that 3 inches in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from the calculation of grain-size fraction. The mechanical analysis data used in this table are not suitable for use in naming textural classes of soil.

deposited as lacustrine sediment. The lacustrine sediment is mainly silt and fine sand. It is mostly along major river systems of the Wolf, Embarrass, Shioc, Black, Bear, and Rat Rivers. Most of these deposits are within 3 miles of the river channels on the first or second terrace above the river. Examples of soils that formed in lacustrine sediment are the Grays, Keowns, Nichols, and Shiocton soils.

An area about 10 miles wide covered with reddish loam to clay loam glacial drift extends from the northeast corner of the county to the southwest corner. Soils in this area are gently sloping to moderately steep. Examples of soils that formed from this drift are the Hortonville, Onaway, Pella, and Solona soils.

The southeastern part of the county is covered with reddish clayey lacustrine sediment that was deposited in Glacial Lake Oshkosh. This area is nearly level except for the steep sides of eroded gullies. The sediment is parent material of the Manawa, Poygan, Winneconne, and other soils.

Some soils in the survey area formed in organic material that accumulated in depressions and in old stream channels. Soils of the Carbondale, Cathro, and Suamico series formed in this kind of material.

Drainage characteristics of soils are determined mainly by relief or by position on the landscape. A drainage sequence is made up of soils that formed in one kind of parent material but have different characteristics because of the degree of wetness. For example, Angelica, Onaway, and Solona soils are members of a drainage sequence. The well drained or moderately well drained Onaway soils are at the higher elevations on the landscape and are gently sloping to moderately steep. They have distinct horizons of clay accumulation. The somewhat poorly drained Solona soils generally occupy foot slopes, borders of wet areas, and drainageways. These soils have red, yellow, and gray mottles, which indicate poor aeration and excess moisture. Their subsoil has some accumulation of clay. The poorly drained Angelica soils are nearly level and are in broad drainageways and depressional areas. In most places these soils have a water table near the surface at some time during the year. The surface layer is dark and distinct, but none of the subsoil horizons have clay accumulations.

### *Time*

Time is needed for changing parent material into soil. It may be much or little, but time is always required for horizon differentiation. Soils can have a profile that is well developed, that is poorly developed, or that is somewhere in between, depending on the length of time the soil-forming factors have been active. Hortonville and Kewaunee soils, for example, have moderately distinct horizons and are considered fairly mature. But soils that formed in recently deposited alluvium, such as Fluvaquents, show little or no profile development.

The five factors of soil formation are so closely

*test data*—Continued

| Percentage passing sieve—[3] | | | Percentage smaller than—[3] | | | | Liquid limit | Plasticity index | Classification | |
|---|---|---|---|---|---|---|---|---|---|---|
| No. 10 | No. 40 | No. 200 | 0.05 mm | 0.02 mm | 0.005 mm | 0.002 mm | | | AASHTO[3] | Unified[4] |
| | | | | | | | *Pct* | | | |
| 100 | 99 | 76 | 70 | 55 | 40 | 32 | 46.1 | 26.9 | A–7–6(16) | CL |
| 91 | 84 | 64 | 58 | 46 | 30 | 21 | 33.8 | 18.0 | A–6(9) | CL |
| 93 | 90 | 45 | 36 | 25 | 14 | 11 | ---------- | NP | A–4(2) | SM |
| 88 | 82 | 32 | 25 | 14 | 6 | 4 | ---------- | NP | A–2–4(0) | SM |
| ---------- | 100 | 93 | 93 | 93 | 88 | 66 | 69.1 | 43.2 | A–7–6(20) | CH |
| 100 | 99 | 97 | 97 | 96 | 92 | 75 | 73.0 | 45.8 | A–7–6(20) | CH |
| ---------- | 100 | 98 | 97 | 96 | 94 | 76 | 85.2 | 57.6 | A–7–6(20) | CH |
| 98 | 97 | 51 | 33 | 12 | 6 | 4 | ---------- | NP | A–4(3) | ML |

[3] Based on AASHTO Designation M145–49 (*1*).

[4] Based on MIL–STD–619B (*2*).

[5] NP means nonplastic.

interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are still unknown.

## Classification

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to the latest literature available (*7, 10*).

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquent (*Aqu,* meaning water, plus *ent* from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Haplaquents (*Hapl,* meaning simple horizons, plus *aquent,* the suborder of Entisols that have an aquic moisture regime).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms

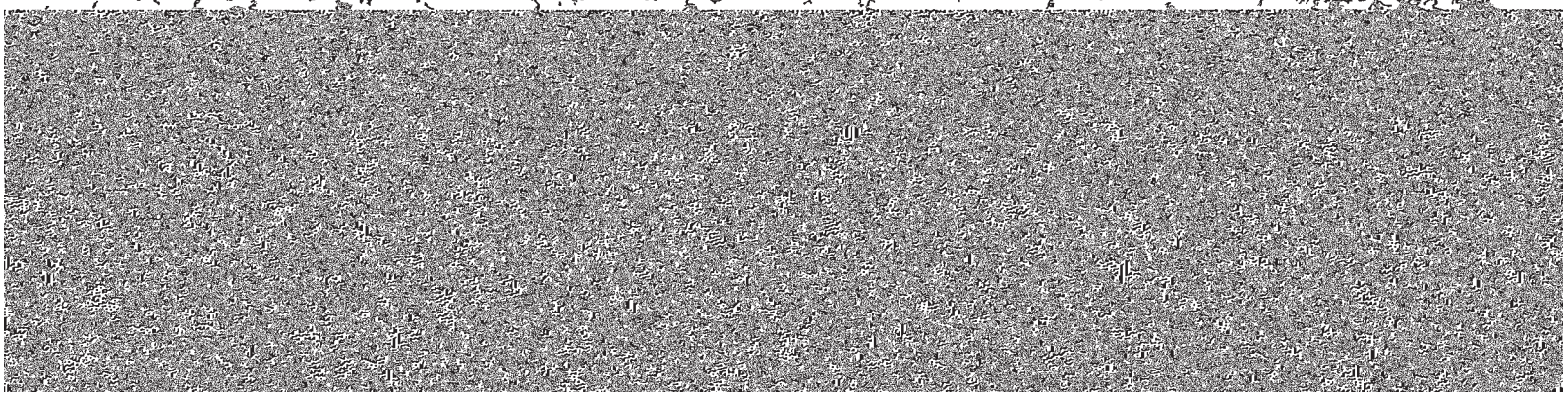
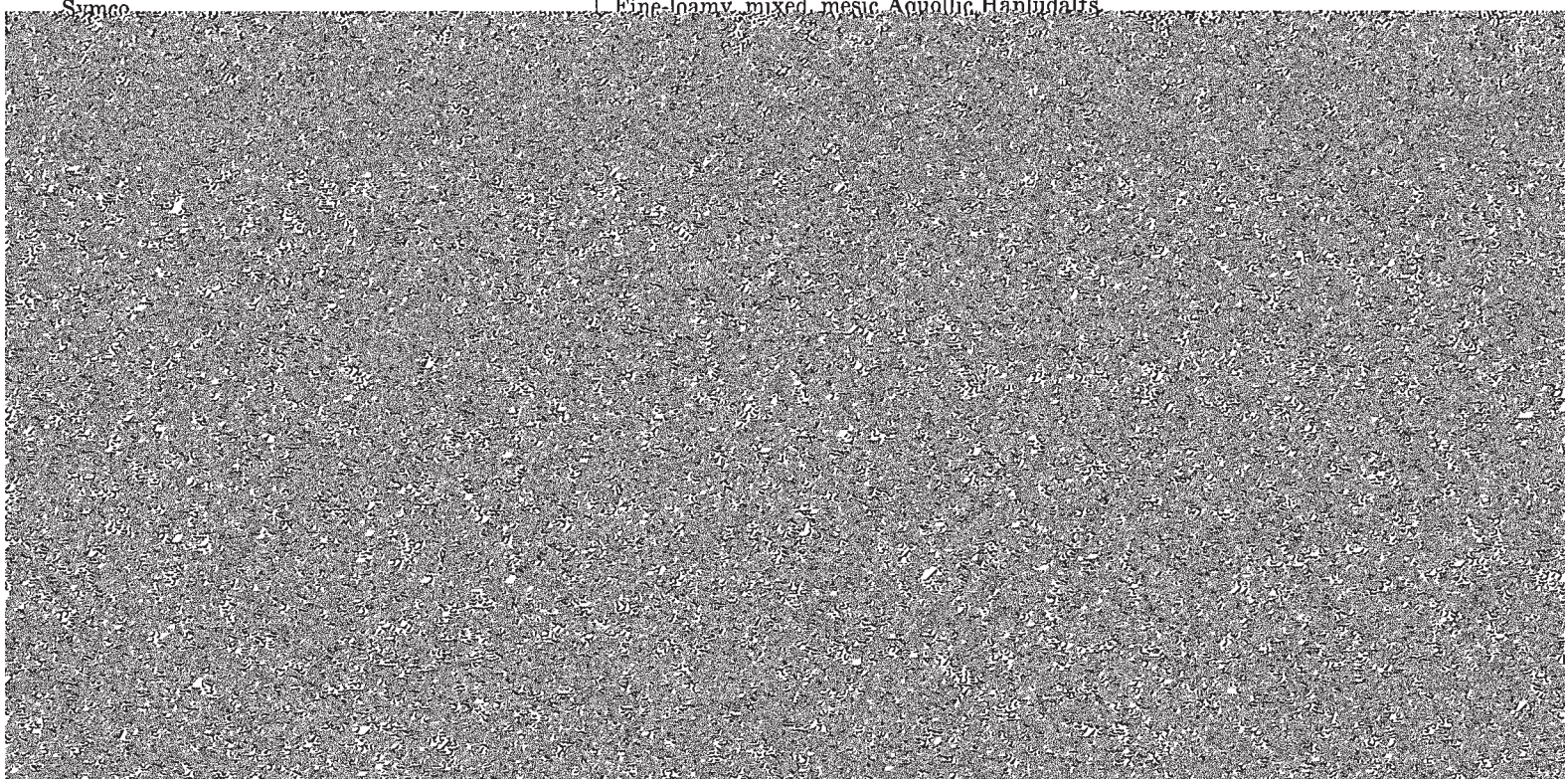


TABLE 15.—*Classification of the soils*

| Soil name | Family or higher taxonomic class |
|---|---|
| Allendale | Sandy over clayey, mixed, frigid Aqualfic Haplorthods. |
| Angelica | Fine-loamy, mixed, nonacid, frigid Aeric Haplaquepts. |
| Bellevue | Fine-loamy, mixed, mesic Fluventic Hapludolls. |
| Bonduel | Fine-loamy, mixed Aquic Eutroboralfs. |
| Borth | Clayey over sandy or sandy-skeletal, mixed, mesic Mollic Hapludalfs. |
| Boyer [1] | Coarse-loamy, mixed, mesic Typic Hapludalfs. |
| Briggsville | Fine, mixed, mesic Typic Hapludalfs. |
| Carbondale | Euic Hemic Borosaprists. |
| Casco | Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludalfs. |
| Cathro | Loamy, mixed, euic Terric Borosaprists. |
| Channahon | Loamy, mixed, mesic Lithic Argiudolls. |
| Deford | Mixed, frigid Typic Psammaquents. |
| Eleva | Coarse-loamy, mixed, mesic Typic Hapludalfs. |
| Fluvaquents | Loamy, mixed, mesic Typic Fluvaquents. |
| Grays | Fine-silty, mixed, mesic Mollic Hapludalfs. |
| Hebron | Fine-loamy, mixed, mesic Typic Hapludalfs. |
| Hortonville | Fine-loamy, mixed, mesic Glossoboric Hapludalfs. |
| Kaukauna | Clayey over loamy, mixed, mesic Mollic Hapludalfs. |
| Keowns | Coarse-loamy, mixed, nonacid, mesic Mollic Haplaquepts. |
| Kewaunee | Fine, mixed, mesic Typic Hapludalfs. |
| Kolberg | Fine, mixed Glossic Eutroboralfs. |
| Lobo | Dysic, frigid Hemic Sphagnofibrists. |
| Manawa | Fine, mixed, mesic Aquollic Hapludalfs. |
| Manistee | Sandy over clayey, mixed, frigid Alfic Haplorthods. |
| Markey | Sandy or sandy-skeletal, mixed, euic Terric Borosaprists. |
| Menominee | Sandy over loamy, mixed, frigid Alfic Haplorthods. |
| Mosel | Fine-loamy, mixed, mesic Aquollic Hapludalfs. |
| Mundelein | Fine-silty, mixed, mesic Aquic Argiudolls. |
| Namur | Loamy, mixed Lithic Haploborolls. |
| Nichols | Coarse-silty, mixed, frigid Typic Eutrochrepts. |
| Onaway | Fine-loamy, mixed, frigid Alfic Haplorthods. |
| Pella | Fine-silty, mixed, mesic Typic Haplaquolls. |
| Poy | Clayey over sandy or sandy-skeletal, mixed, mesic Typic Halplaquolls. |
| Poygan | Fine, mixed, mesic Typic Haplaquolls. |
| Rondeau | Marly, euic Limnic Borosaprists. |
| Rousseau | Sandy, mixed, frigid Entic Haplorthods. |
| Shawano | Mixed, frigid Typic Udipsamments. |
| Shiocton | Coarse-silty, mixed Aquic Haploborolls. |
| Solona | Fine-loamy, mixed Aquic Eutroboralfs. |
| Suamico [2] | Clayey, mixed, euic Terric Borosaprists. |
| Symco | Fine-loamy, mixed, mesic Aquollic Hapludalfs. |



These are relief and drainage, geology, climate, water supply, and vegetation.

### *Relief and drainage*

The relief of Outagamie County was formed mostly by recent glaciation. The southeastern corner of the county is mostly gently sloping and has a thick mantle of clayey glacial till. The northwestern corner of the county is mostly nearly level and is covered with lacustrine sediment that typically has a loamy texture. The remainder of the county consists of a strip about 10 miles wide running from the northeast corner to the southwest corner. It is mostly gently sloping and

sition between summer and winter. In many years, the change from spring to summer is gradual, but the change from summer to fall is usually abrupt.

Storms accompany changes from one air mass to another in all seasons, but particularly from late fall to the middle of spring when a change occurs every 2 or 3 days. Nearby Lake Winnebago slightly modifies temperatures during the time of the year that it is not frozen, usually from mid-April to mid-November. Table 16 gives temperature and precipitation data. Table 17 shows the probability of the last freezing temperatures in spring and the first in fall.

The data in tables 16 and 17 were recorded at

TABLE 16.—*Temperature and precipitation*

[Data recorded at Appleton, Wisconsin from 1930 to 1959]

| Month | Temperature | | | | | | Precipitation | | |
|---|---|---|---|---|---|---|---|---|---|
| | Average daily maximum | Average daily minimum | Maximum | | Minimum | | Average monthly total | Average snow and sleet | 0.1 inch or more |
| | | | 90° F and above | 32° F and below | 32° F to 0° F | 0° F and below | | | |
| | °F | °F | Days | Days | Days | Days | In | In | Days |
| January | 26.1 | 9.8 | 0 | 21 | 31 | 8 | 1.31 | 10.6 | 4 |
| February | 28.4 | 11.1 | 0 | 18 | 28 | 6 | 1.27 | 9.1 | 4 |
| March | 37.5 | 22.0 | 0 | 9 | 27 | 1 | 1.77 | 9.7 | 5 |
| April | 53.4 | 34.8 | 0 | 1 | 13 | 0 | 2.60 | 1.6 | 6 |
| May | 66.8 | 46.2 | (1) | 0 | 1 | 0 | 3.00 | 0.2 | 7 |
| June | 77.0 | 56.9 | 2 | 0 | 0 | 0 | 3.98 | 0.0 | 7 |
| July | 82.6 | 61.9 | 5 | 0 | 0 | 0 | 3.00 | 0.0 | 6 |
| August | 80.4 | 60.2 | 4 | 0 | 0 | 0 | 2.86 | 0.0 | 6 |
| September | 71.2 | 51.8 | 1 | 0 | (1) | 0 | 3.18 | (2) | 6 |
| October | 59.2 | 41.2 | 0 | 0 | 5 | 0 | 1.95 | 0.2 | 5 |
| November | 41.8 | 27.8 | 0 | 6 | 21 | (1) | 2.14 | 3.7 | 5 |
| December | 29.9 | 15.9 | 0 | 17 | 29 | 4 | 1.39 | 8.3 | 4 |
| Year | 54.5 | 36.6 | 12 | 72 | 155 | 19 | 28.45 | 43.4 | 65 |

[1] Less than one-half day.

[2] Trace.

should be similar. Possible sunshine averaged about 40 percent for November and December, 60 percent or more for May through September, and between 50 and 60 percent for the remaining months.

### *Water supply*

The major sources of ground water in Outagamie County are the St. Peter Sandstone of Ordovician age and the sandstones of the Upper Cambrian series (*5*). Where they are sufficiently thick, glacial sand and gravel are an important source of ground water.

Ground water in the survey area is under water table and artesian conditions. The source of the ground water is precipitation that falls on the surface and percolates downward into the underlying materials. Regional movement of the ground water in the eastern third of the survey area is controlled by the bedrock structure, and the discharge is toward the east and south. Throughout the rest of the survey area the movement of water is controlled mainly by bedrock and surface topography, and the water moves toward streams and bedrock valleys.

The ground water level is usually not far below the surface, generally less than 100 feet. In the north-

TABLE 17.—*Probabilities of last freezing temperatures in spring and first in fall*

[Data recorded at Appleton from 1930 to 1959]

| Probability | Dates for given probability and temperature of— | | | | |
|---|---|---|---|---|---|
| | 16° F or below | 20° F or below | 24° F or below | 28° F or below | 32° F or below |
| Spring: | | | | | |
| 2 years in 10 later than | Mar. 31 | Apr. 8 | Apr. 16 | Apr. 29 | May 13 |
| 4 years in 10 later than | Mar. 24 | Apr. 1 | Apr. 9 | Apr. 22 | May 6 |
| 6 years in 10 later than | Mar. 17 | Mar. 25 | Apr.2 | Apr. 16 | Apr. 30 |
| 8 years in 10 later than | Mar. 10 | Mar. 17 | Mar. 25 | Apr. 8 | Apr. 23 |
| Fall: | | | | | |
| 2 years in 10 earlier than | Nov. 11 | Nov. 3 | Oct. 25 | Oct. 12 | Oct. 3 |
| 4 years in 10 earlier than | Nov. 18 | Nov. 10 | Nov. 1 | Oct. 20 | Oct. 10 |
| 6 years in 10 earlier than | Nov. 25 | Nov. 17 | Nov. 8 | Oct. 26 | Oct. 17 |
| 8 years in 10 earlier than | Dec. 3 | Nov. 24 | Nov. 16 | Nov. 3 | Oct. 24 |

western quarter of the survey area, ground water is mostly within 20 feet of the surface.

### *Natural vegetation*

Most of the northern part of Outagamie County was a mixed conifer and hardwood forest; the southern and north-central parts were hardwood forest. Approximately 69,000 acres, or 17 percent of the county, remains in woodland.

The wetlands of the county support various sedges, grasses, and such water-tolerant trees and shrubs as American elm, tamarack, white-cedar, willow, tag alder, and dogwood. Approximately 38,000 acres, or 22 percent of the wetlands, remain in their natural condition.

## Cultural Features

In this section the history, transportation and schools, industrial activity, and trends in land use in Outagamie County are discussed.

### *History*

Before the first permanent settlers arrived, Outagamie County was the fishing and hunting grounds of the Winnebago and Menominee Indian tribes. The Outagamie tribe moved into the Fox Valley after 1650. The tribe clashed with the early French traders; a series of wars followed, and the Outagamie tribe eventually broke up.

Most of the early French explorers, fur traders, and missionaries who came to eastern Wisconsin passed through Outagamie County. The earliest of these was Jean Nicolet who passed through in 1624 on his way to visit the Indians at Lake Winnebago.

The first settler was Domitrius DeCharme, who

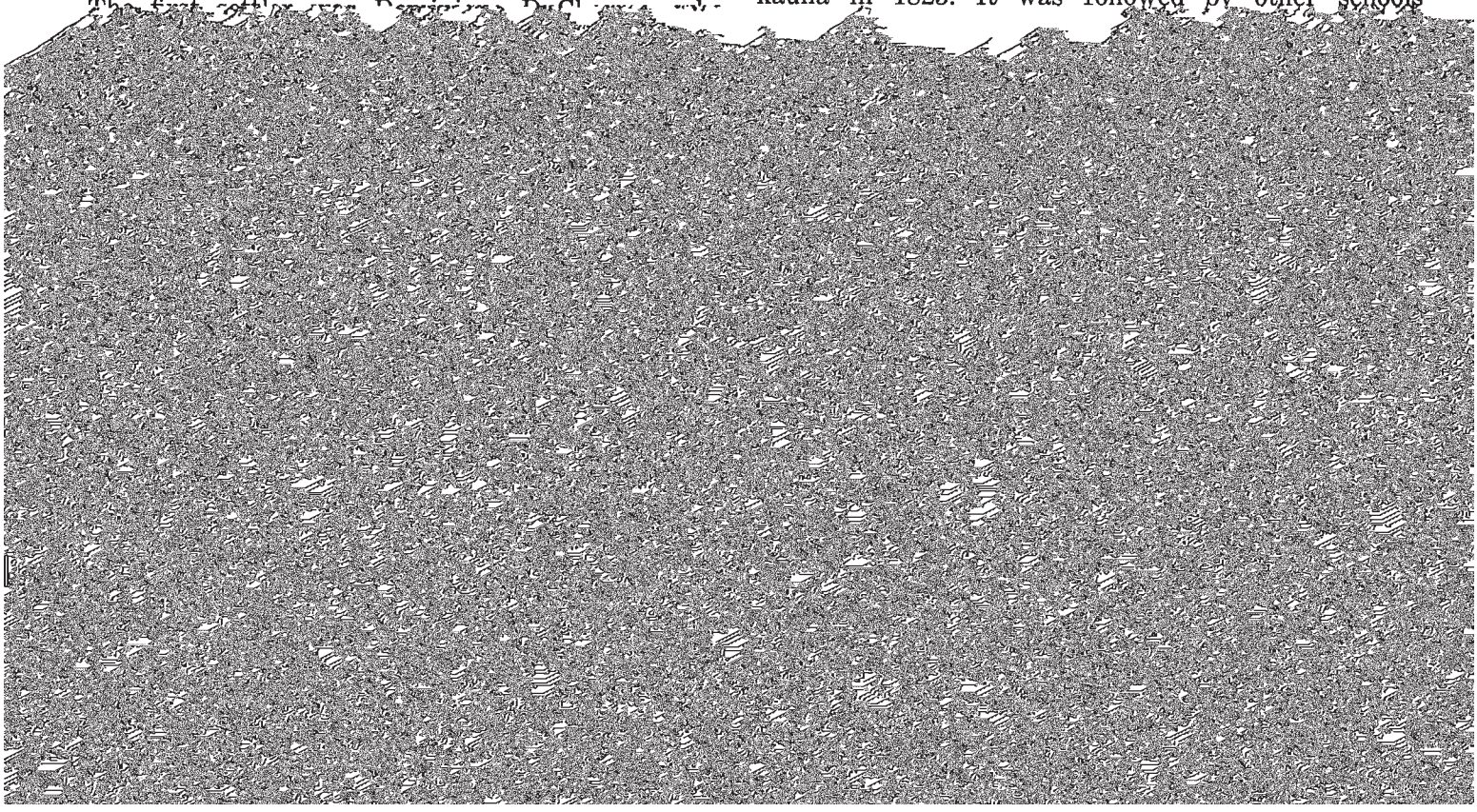
The arrival of Louis Perrot in 1855 was important to the agricultural development of the county. He was the father of the cheese-making industry, which, in turn, was a forerunner of the dairy industry that is prevalent in the county today.

Industry developed at the same time as agriculture and logging. The Fox River drops 170 feet from Lake Winnebago to Green Bay, 150 feet of this drop in Outagamie County. This water power made the area a natural place for industrial development.

There were three distinct phases in the development of industry in the area. The original lumbering was succeeded by flour milling, which was in turn eclipsed by the paper industry. These phases overlapped. A sawmill and a flour mill often were side by side on the river. The lumber business and the flour business began at approximately the same time. Augustin Grignon built both a sawmill and grist mill in 1818. In 1828 a flour mill was built in Kaukauna, across the river from Grignon's mills, but it was not until the 1850's that the flour industry began to flourish. The flour mills moved to Minneapolis, and the local mills were converted to pulp and paper mills. The earliest paper mill in Outagamie County was located at Appleton in about 1853.

Other industrial enterprises in the county included tanning houses, wire works, watch-making shops, woolen mills, machine shops, blast furnaces, nail factories, farm implement factories, and even a cracker factory. Many of these enterprises exist today. The older enterprises together with many new ones make for much diversity of industry in the county.

The earliest school on record was located in Kaukauna in 1823. It was followed by other schools



### *Industry*

Outagamie County in the Fox River Valley is one of the more important manufacturing and agricultural counties in Wisconsin. Paper making is the main industry. Also important are metal-working and printing and the production of food and beverages, textiles, leather goods, wood products, and chemicals. Manufacturing has made gains since the early post-war period. Relative statewide gains in employment, payroll, and value added by manufacturing, were recorded during the period 1947 to 1958. Growth has

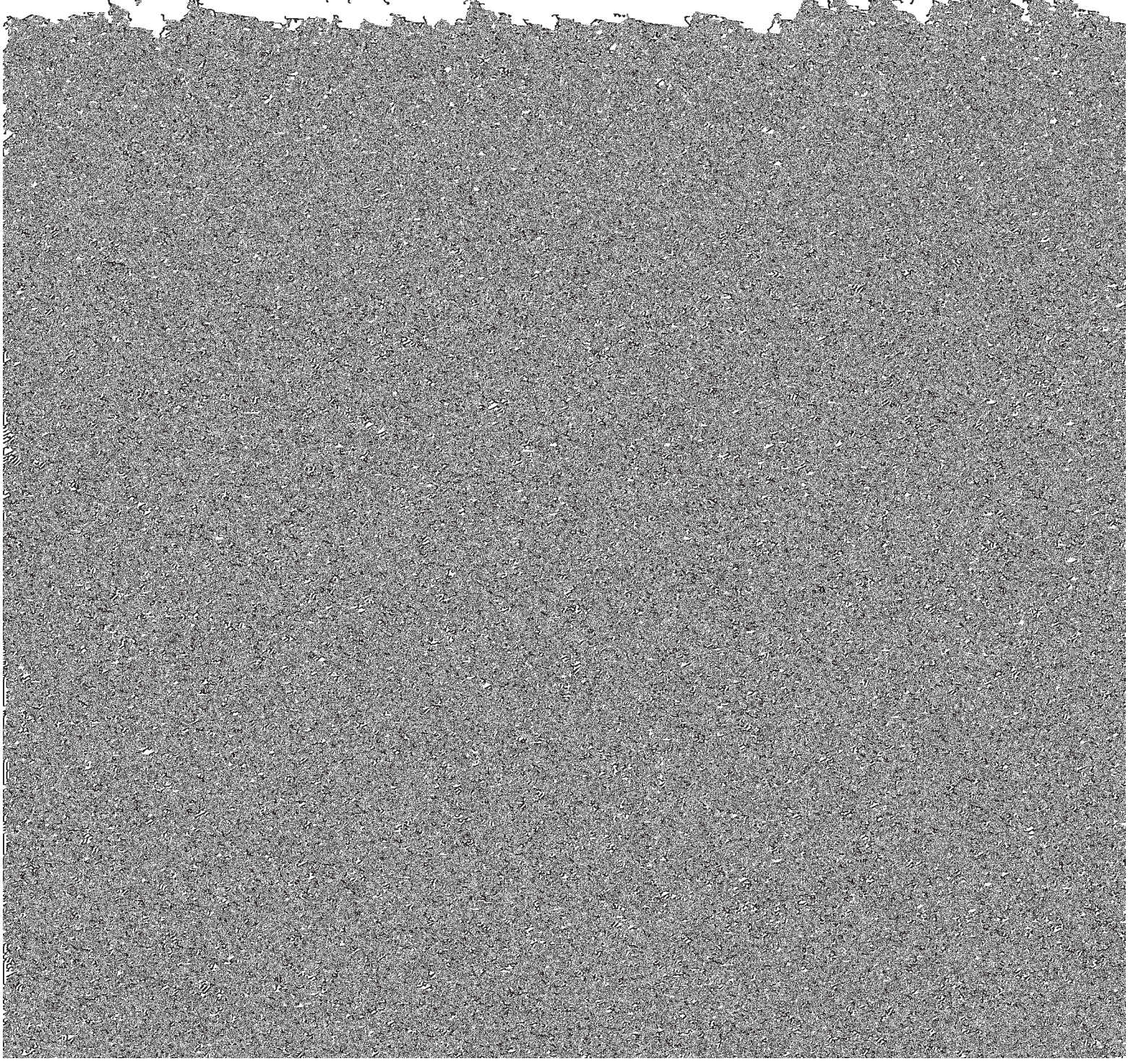
(11) Wisconsin Department of Natural Resources. 1968. Wisconsin forest resources, Lake Winnebago survey report.

## *Glossary*

**Aggregate, soil.** Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

**Alluvium.** Material, such as sand, silt, or clay, deposited on land by streams.

**Area reclaim.** An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and ero-



organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

*A2 horizon.*—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

*B horizon.*—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of

cent; *high*, 4.0 to 8.0 percent; and *very high*, more than 8 percent.

**Parent material.** The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

**Peat.** Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture.

**Ped.** An individual natural soil aggregate, such as a granule, a prism, or a block.

**Percolation.** The downward movement of water through the soil.

**Perm, slowly.** The slow movement of water through the soil

reaction, consistence, and mineralogical and chemical composition.

**Shrink-swell.** The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

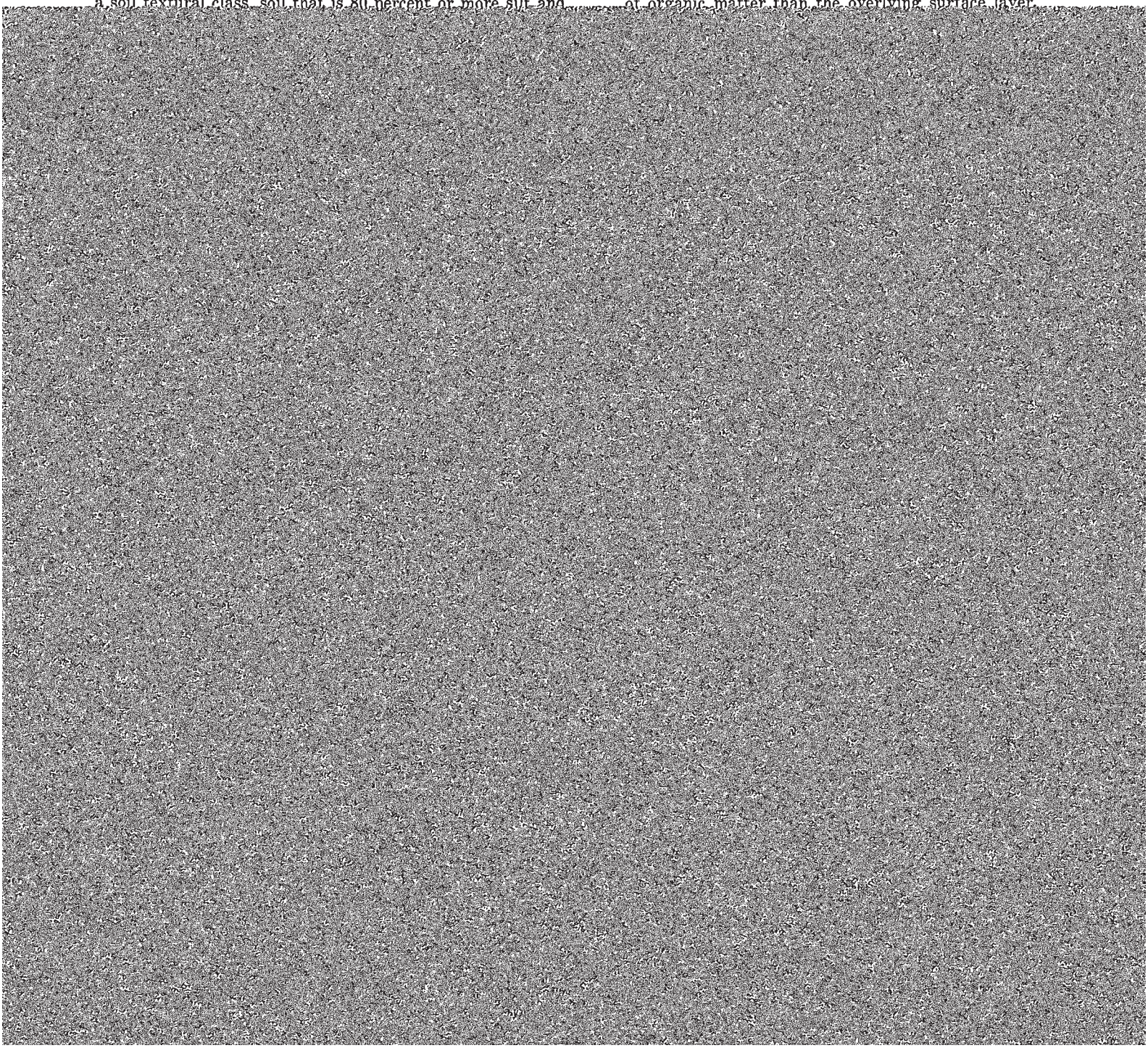
**Silt.** As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and

ular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

**Subsoil.** Technically, the B horizon; roughly, the part of the solum below plow depth.

**Substratum.** The part of the soil below the solum.

**Subsurface layer.** Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.



## GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and the description of the soil series to which the mapping unit belongs. Capability units are described on pages 47 to 53. Woodland group symbols are described on page 54.

| Map symbol | Mapping unit | Page | Capability unit | Woodland group |
|---|---|---|---|---|
| | | | Symbol | Symbol |
| AdA | Allendale loamy fine sand, 0 to 3 percent slopes | 8 | IIIw-6 | 3w |
| Ax | Angelica silt loam | 10 | IIw-1 | 4w |
| Bc | Bellevue silt loam | 11 | IIw-11 | 3o |
| BnA | Bonduel silt loam, 0 to 3 percent slopes | 12 | IIw-2 | 3o |
| BoA | Borth silt loam, 0 to 3 percent slopes | 12 | IIs-7 | 3c |
| BrB | Boyer loamy sand, 2 to 6 percent slopes | 13 | IIIs-4 | 2s |
| BrC2 | Boyer loamy sand, 6 to 12 percent slopes, eroded | 13 | IIIe-7 | 2s |
| BrD2 | Boyer loamy sand, 12 to 20 percent slopes, eroded | 13 | IVe-7 | 2s |
| BtA | Briggsville silt loam, 0 to 2 percent slopes | 14 | IIs-7 | 2c |
| BtB | Briggsville silt loam, 2 to 6 percent slopes | 14 | IIe-6 | 2c |
| Ca | Carbondale muck | 15 | IVw-9 | 3w |
| CcB | Casco loam, 2 to 6 percent slopes | 15 | IIIe-3 | 3s |
| CcC2 | Casco loam, 6 to 12 percent slopes, eroded | 15 | IVe-3 | 3s |
| CcD2 | Casco loam, 12 to 20 percent slopes, eroded | 16 | VIe-3 | 3s |
| Cm | Cathro muck | 16 | IVw-8 | 3w |
| CnB | Channahon silt loam, 2 to 6 percent slopes | 17 | IIIe-3 | 3d |
| De | Deford loamy fine sand | 17 | IVw-5 | 5w |
| ElB | Eleva fine sandy loam, 2 to 6 percent slopes | 18 | IIIs-4 | 3o |
| ElC2 | Eleva fine sandy loam, 6 to 15 percent slopes, eroded | 18 | IIIe-7 | 3o |
| Fu | Fluvaquents | 18 | Vw-14 | 4w |
| Gp | Gravel pits | 18 | ------ | -- |
| GrA | Grays silt loam, 0 to 2 percent slopes | 19 | I-1 | 1o |
| GrB | Grays silt loam, 2 to 6 percent slopes | 19 | IIe-1 | 1o |
| HeB | Hebron loam, 2 to 6 percent slopes | 20 | IIe-6 | 2o |
| HnB | Hortonville fine sandy loam, 2 to 6 percent slopes | 20 | IIe-1 | 1o |
| HnC2 | Hortonville fine sandy loam, 6 to 12 percent slopes, eroded | 21 | IIIe-1 | 1o |
| HrB | Hortonville silt loam, 2 to 6 percent slopes | 21 | IIe-1 | 1o |
| HrC2 | Hortonville silt loam, 6 to 12 percent slopes, eroded | 21 | IIIe-1 | 1o |
| HrD2 | Hortonville silt loam, 12 to 20 percent slopes, eroded | 21 | IVe-2 | 1r |
| HrE | Hortonville silt loam, 20 to 30 percent slopes | 21 | VIe-1 | 1r |
| HsB | Hortonville silt loam, limestone substratum, 2 to 6 percent slopes | 21 | IIe-1 | 1o |
| HsC2 | Hortonville silt loam, limestone substratum, 6 to 12 percent slopes, eroded | 21 | IIIe-1 | 1o |
| HtB | Hortonville-Symco silt loams, 2 to 6 percent slopes | 22 | IIe-1 | 1o |
| KaA | Kaukauna silty clay loam, 0 to 3 percent slopes | 23 | IIs-7 | 2c |
| Ke | Keowns silt loam | 23 | IIIw-3 | 1w |
| KhB | Kewaunee silt loam, 2 to 6 percent slopes | 24 | IIe-6 | 2c |
| KhC2 | Kewaunee silt loam, 6 to 12 percent slopes, eroded | 24 | IIIe-6 | 2c |
| KhD2 | Kewaunee silt loam, 12 to 20 percent slopes, eroded | 24 | IVe-2 | 2c |
| KkE3 | Kewaunee soils, 20 to 45 percent slopes, severely eroded | 25 | VIIe-6 | 2c |
| KlB | Kewaunee-Manawa complex, 2 to 6 percent slopes | 25 | IIw-2 | 2c |
| KoB | Kolberg silt loam, 1 to 6 percent slopes | 25 | IIe-2 | 2c |
| KoC2 | Kolberg silt loam, 6 to 12 percent slopes, eroded | 26 | IIIe-2 | 2c |
| Ln | Limestone quarries | 26 | ------ | -- |
| Lo | Lobo peat | 26 | VIIw-10 | 4w |
| McA | Manawa silty clay loam, 1 to 3 percent slopes | 27 | IIw-2 | 2c |
| MeB | Manistee loamy fine sand, 2 to 6 percent slopes | 28 | IIIe-4 | 2s |
| MeC2 | Manistee loamy fine sand, 6 to 12 percent slopes, eroded | 28 | IVe-4 | 2s |
| MfB | Manistee fine sandy loam, 2 to 6 percent slopes | 28 | IIIe-4 | 2s |
| Mk | Markey muck | 29 | IVw-7 | 3w |
| MsB | Menominee loamy fine sand, loamy substratum, 2 to 6 percent slopes | 29 | IIIe-4 | 1s |
| MsC2 | Menominee loamy fine sand, loamy substratum, 6 to 12 percent slopes, eroded | 30 | IVe-4 | 1s |
| MtA | Mosel silt loam, 0 to 3 percent slopes | 30 | IIw-2 | 2o |
| MuA | Mundelein silt loam, 0 to 3 percent slopes | 31 | IIw-4 | 4o |
| NaB | Namur silt loam, 1 to 6 percent slopes | 31 | VIs-5 | 4d |

GUIDE TO MAPPING UNITS--Continued

| Map symbol | Mapping unit | Page | Capability unit | Woodland group |
|---|---|---|---|---|
| | | | Symbol | Symbol |
| NfA | Nichols very fine sandy loam, 0 to 2 percent slopes | 32 | I-1 | 1o |
| NfB | Nichols very fine sandy loam, 2 to 6 percent slopes | 32 | IIe-1 | 1o |
| NsA | Nichols very fine sandy loam, clayey substratum, 0 to 2 percent slopes- | 32 | I-1 | 1o |
| NsB | Nichols very fine sandy loam, clayey substratum, 2 to 6 percent slopes- | 32 | IIe-1 | 1o |
| OhB | Onaway loam, 2 to 6 percent slopes | 33 | IIe-2 | 2d |
| OhC2 | Onaway loam, 6 to 12 percent slopes, eroded | 33 | IIIe-2 | 2d |
| OhD2 | Onaway loam, 12 to 20 percent slopes, eroded | 33 | IVe-2 | 2d |
| OlB | Onaway-Solona complex, 2 to 6 percent slopes | 33 | IIe-2 | -- |
| | Onaway part | -- | -------- | 2d |
| | Solona part | -- | -------- | 2o |
| Pe | Pella silt loam | 34 | IIw-1 | 3w |
| Pf | Poy silty clay loam | 35 | IIw-5 | 2w |
| Po | Poygan silty clay loam | 36 | IIw-1 | 2w |
| Ra | Rock outcrop | 36 | VIIIs-10 | -- |
| Rd | Rondeau muck | 36 | IVw-7 | 5w |
| RoB | Rousseau loamy fine sand, 2 to 6 percent slopes | 37 | IVs-3 | 2s |
| SeC | Shawano fine sand, rolling | 38 | VIIs-9 | 2s |
| SeD | Shawano fine sand, hilly | 38 | VIIs-9 | 2s |
| ShA | Shiocton silt loam, 0 to 3 percent slopes | 39 | IIw-4 | 1o |
| SkA | Shiocton silt loam, clayey substratum, 0 to 3 percent slopes | 39 | IIw-4 | 1o |
| SnB | Shiocton-Nichols complex, 2 to 6 percent slopes | 39 | IIe-1 | 1o |
| SoA | Solona silt loam, 1 to 3 percent slopes | 40 | IIw-2 | 2o |
| Su | Suamico muck | 40 | IVw-8 | 3w |
| SyA | Symco silt loam, 1 to 3 percent slopes | 41 | IIw-2 | 1o |
| SzA | Symco variant, 0 to 3 percent slopes | 41 | IIw-5 | 2w |
| Uf | Udifluvents | 42 | IIw-11 | 3o |
| Uo | Udorthents | 42 | -------- | -- |
| WaA | Wainola loamy fine sand, 0 to 3 percent slopes | 42 | IVw-5 | 3w |
| Wb | Will silt loam | 43 | IIw-5 | 4w |
| WnA | Winneconne silty clay loam, 0 to 2 percent slopes | 44 | IIs-7 | 2c |
| WnB | Winneconne silty clay loam, 2 to 6 percent slopes | 44 | IIe-6 | 2c |
| WnC2 | Winneconne silty clay loam, 6 to 12 percent slopes, eroded | 44 | IIIe-6 | 2c |
| ZtA | Zittau silty clay loam, 0 to 3 percent slopes | 45 | IIw-5 | 3c |

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